

# BrainVision Recorder 1.10 User Manual

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Version 004

24 September 2008



## Imprint

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User Manual version: 004

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## About this manual

This User Manual describes the EEG recording software BrainVision Recorder.

The User Manual is an integral part of the software. This Manual must be precisely adhered to in order to ensure that the software is employed as intended and operated correctly. It is therefore essential that you read this User Manual in full.



The current User Manual is intended for specialist staff with experience in performing psychophysiological measurements. **TARGET GROUP**

The User Manual contains specific information required for installing and operating the BrainVision Recorder. It describes in detail the functions and settings provided by the software. **CONTENTS OF THE USER MANUAL**

This User Manual refers to Version 1.10 of the BrainVision Recorder.

Please report to us any errors or faults that you see or encounter in the present User Manual or when using the Software. In this case, please contact: **REPORTING ERRORS**

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## Symbols used in the text

The symbols used in this User Manual have the following meanings:



The **Warning** symbol indicates that incorrect use of the devices may result in a health hazard to the user and/or a third-party. Incorrect use means non-adherence to the guidelines set out in the current User Manual.



The **Stop** symbol indicates that you should not carry out a particular action.



The **Note** symbol draws your attention to additional information relating to the current topic.

## **1 Intended Use**

The BrainVision Recorder is intended for use on humans.

The BrainVision Recorder is used for controlling EEG amplifiers and for recording EEG and ExG signals (e.g. ECG, EOG and EMG signals) and sensor data with the aid of electrodes, sensors and a personal computer.

The derived data is stored on the PC as digitized raw data. This data can then be further analyzed at a subsequent time and in a different location, for instance using the EEG analysis software BrainVision Analyzer.

Recording of the EEG/ExG signals and sensor data is intended for research purposes only. This excludes utilization of the software for diagnostic and therapeutic purposes, the monitoring of body functions or other medical diagnosis or therapeutic activities.

The BrainVision Recorder may only be used by appropriately trained specialist staff and the specialist staff must be present during use.

Irrespective of any liability on our part, the specialist staff must observe the relevant national stipulations for operators (in Germany, this is the Medical Devices Act (MPG) and other relevant directives).



## 2 Information on the software

### 2.1 Product identification

|                                                                              |                                                                                                                                                                                                                                                                                                       |
|------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Product designation:                                                         | BrainVision Recorder                                                                                                                                                                                                                                                                                  |
| Manufacturer:                                                                | Brain Products GmbH<br>Zeppelinstraße 7<br>D-82205 Gilching (Munich)<br>Phone: +49 8105 73384 - 0<br>Fax: +49 8105 73384 - 33<br>Web site: <a href="http://www.brainproducts.com">http://www.brainproducts.com</a><br>Email: <a href="mailto:techsup@brainproducts.com">techsup@brainproducts.com</a> |
| Classification according to EU Directive 93/42 EEC (MDD), Annex IX, Rule 12: | Class I with measuring function                                                                                                                                                                                                                                                                       |
| Classification according to DIN EN 62304:                                    | Class A – “No injury or damage to health is possible”                                                                                                                                                                                                                                                 |
| UMDNS number:                                                                | 12-389, Acquisition Software for EEGs and Evoked Potentials                                                                                                                                                                                                                                           |
| GMND code:                                                                   | 36163                                                                                                                                                                                                                                                                                                 |
| Approved EEG amplifiers:                                                     | BrainAmp Standard<br>BrainAmp DC<br>BrainAmp MR<br>BrainAmp MR plus<br>BrainAmp ExG<br>BrainAmp ExG MR<br>QuickAmp<br>FirstAmp<br>V-Amp                                                                                                                                                               |
| Other approved hardware:                                                     | National Instruments NI 6071e A/D converter board                                                                                                                                                                                                                                                     |

## 2.2 CE mark



The CE mark confirms that the product fulfills all the basic requirements stipulated in the Medical Devices Directive 93/42/EEC (MDD), Annex I. 0535 is the identification number of the Notified Body who issued the approval.

## 2.3 Application environment

The BrainVision Recorder is approved as an applied part in the patient environment provided that the PC on which the recorder is running is a PC approved for medical applications in accordance with IEC 60601-1.

If, however, you run the Recorder on a PC which is not approved in accordance with IEC 60601-1, this PC must be located and used outside the patient environment.

If you record EEG/ExG signals in an MRI scanner, the PC must always be used outside the MRI scanner room.

## 3 Preface

The BrainVision Recorder is a powerful and flexible recording program. Its particular strengths lie in the following features:

The program is structured in such a way that it is possible to control different amplifiers.

The number of channels is restricted only by the EEG amplifier that is being used. In itself, the internal structure of the BrainVision Recorder allows you to work with an unlimited number of channels.

The fact that OLE automation has been implemented allows you to control the BrainVision Recorder remotely and monitor its internal status using other programs.

The “Remote Data Access” (RDA) method allows the user to acquire and record the digital signals with their own programs while the EEG is being displayed. This method can be used across different computers. Possible applications for RDA include bio-feedback and signal quality analysis.

Optional segmentation on the basis of event markers reduces the storage space required for EEG files.

The optional averaging function on the basis of event markers allows evoked potentials to be generated during recording.

The data acquired can be filtered separately for representation, segmentation/averaging and storage.



## 4 Installation

Under normal conditions, the BrainVision Recorder does not impact on any programs already installed. Brain Products GmbH, however, only guarantees that programs will interact without problems if the programs concerned have been tested for compatibility. This applies to the BrainVision Analyzer analysis software and to the Microsoft operating systems Windows® XP and Vista provided that no modifications to the configuration of the operating system as delivered has been undertaken (including official service packs and updates).

The following system requirements apply in respect of hardware and software:

### SYSTEM REQUIREMENTS

- Windows® XP Service Pack 3 or Windows® Vista Service Pack 1.

Note that the QuickAmp PCI and QuickAmp USB are not compatible with Windows® Vista.



- Minimum configuration: Intel Pentium III processor, 1 Ghz or compatible, graphics adapter with a resolution of 1024 x 768 pixels and 32768 colors.

Windows® XP: 512 MB RAM,

Windows® Vista: 1GB RAM.

- 1 GB free hard disk space. Additional storage requirements depend on the extent of the data to be processed.
- We recommend a monitor with a screen diagonal of at least 17". For more than 32 channels, you should use a 21" monitor.

Start Windows® and insert the supplied CD ROM into one of your CD ROM drives.

### INSTALLATION

If your PC is set up to autostart a CD-ROM, the menu will appear after a few moments to guide you through the installation. Follow the instructions in the program.

Note that you can only install the Recorder if you are logged in as Administrator.



If your PC is not set up to autostart CD ROMs, proceed as follows under Windows® XP:

### WINDOWS® XP

- From the task bar, choose **Start > Run** and click **Browse**;
- Navigate to your CD ROM drive and double-click the file **setup.exe** and follow the instructions in the program.

## WINDOWS® VISTA

If your PC is not set up to autostart CD ROMs, proceed as follows under Windows® Vista: Open the CD ROM drive in Windows® Explorer and in the folder **Brain Vision CD**, double-click the file **Autorun.exe** and run it with Administrator permissions:

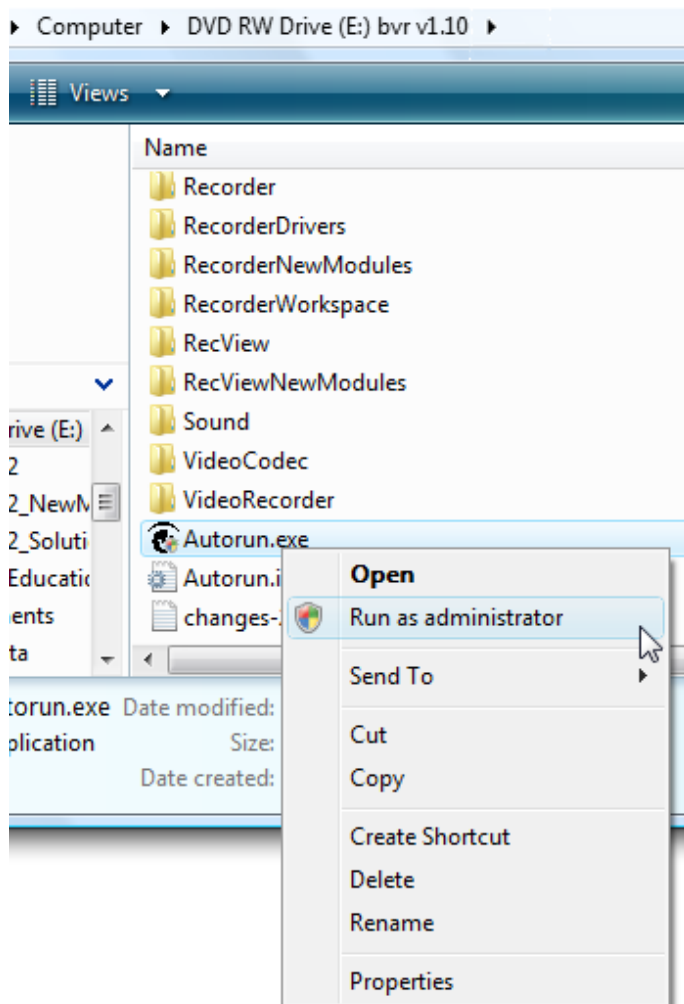


FIGURE 4–1 INSTALLING THE RECORDER UNDER WINDOWS® VISTA

When you run the installation file, the **Brain Vision Setup CD-ROM** dialog box opens.

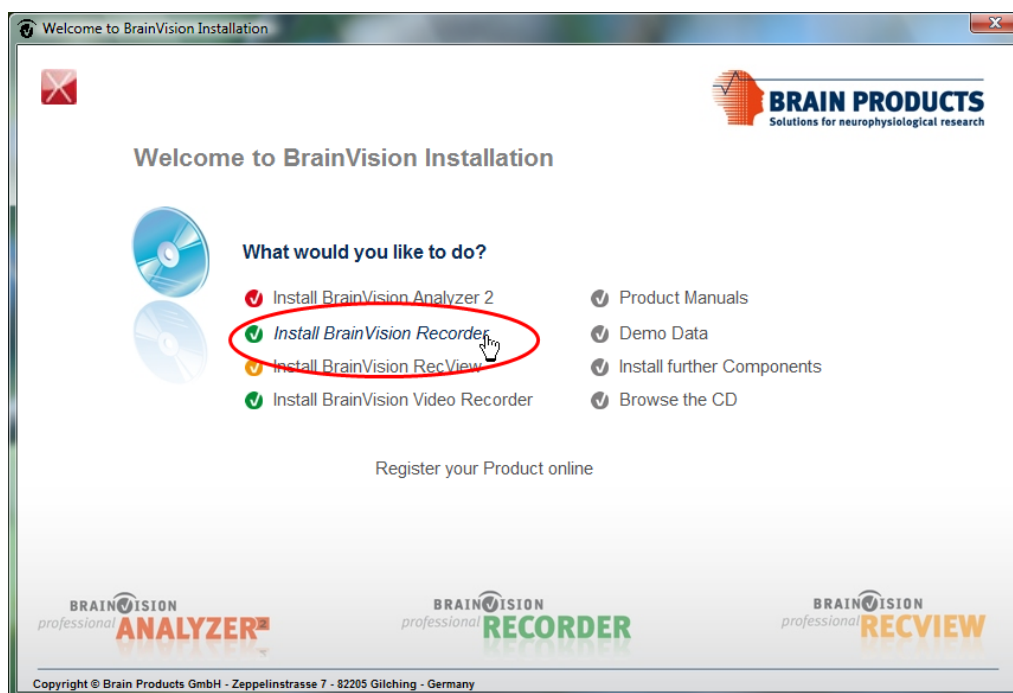


FIGURE 4—2 SETUP DIALOG BOX UNDER WINDOWS® VISTA

Click the button **Install Brain Vision Recorder** and follow the instructions in the program.

During the installation procedure, you must agree to installation of the driver software in the **Windows Security** dialog box by clicking the entry **Install this driver software anyway**:

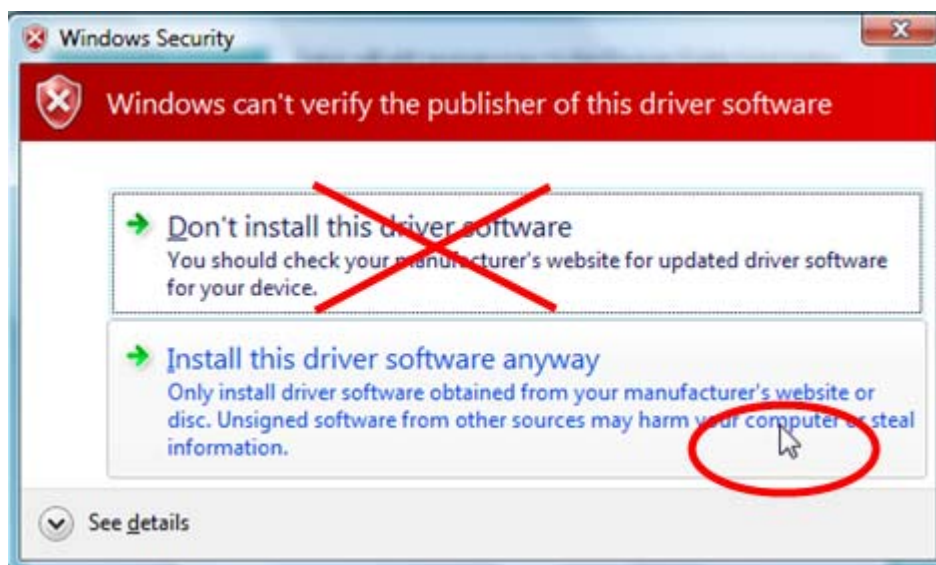


FIGURE 4–3 ACCEPTING INSTALLATION OF THE DRIVER SOFTWARE

Connect the supplied USB dongle to one of the USB ports of your PC before you start the recorder.

Start the Recorder by double-clicking the Recorder shortcut , which you will find on your desktop after installation has been completed successfully.

Alternatively, you can call the Recorder from the task bar by choosing **Start > Vision Recorder**.

## 5 Familiarization and operation

Ensure that the hibernation mode in Windows® is **ALWAYS** deactivated.

RESTRICTIONS TO USE

### 5.1 First steps

Note that you must select an amplifier the first time you start the program. This can only be done in Administrator mode. If you do not do this, the functions needed are not available (see Figure 5–2). This applies to both Windows® XP and Vista.

Under Windows® XP, start the Recorder by right-clicking the Recorder shortcut and choosing **Run As....** This opens the **Run As** dialog box. Ensure that the Administrator account is selected.

WINDOWS® XP

Under Windows® Vista, start the Recorder by right-clicking the Recorder shortcut and choosing **Run as Administrator**.

WINDOWS® VISTA

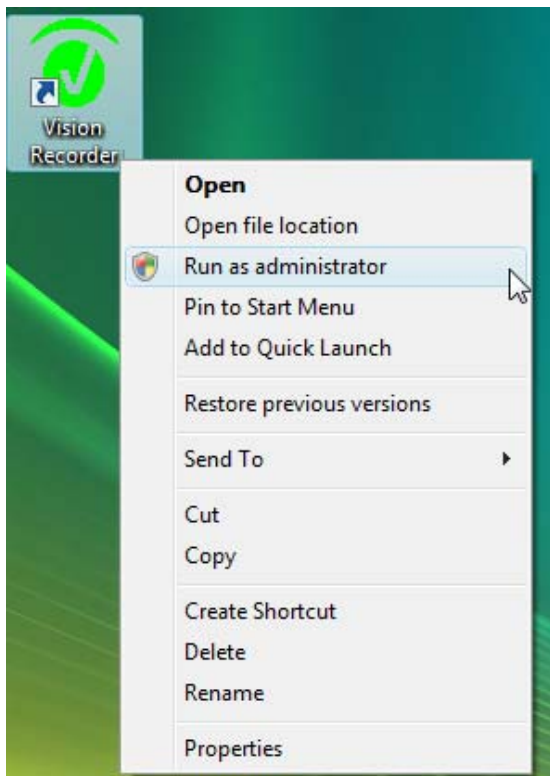


FIGURE 5—1 STARTING THE RECORDER FOR THE FIRST TIME UNDER WINDOWS® VISTA

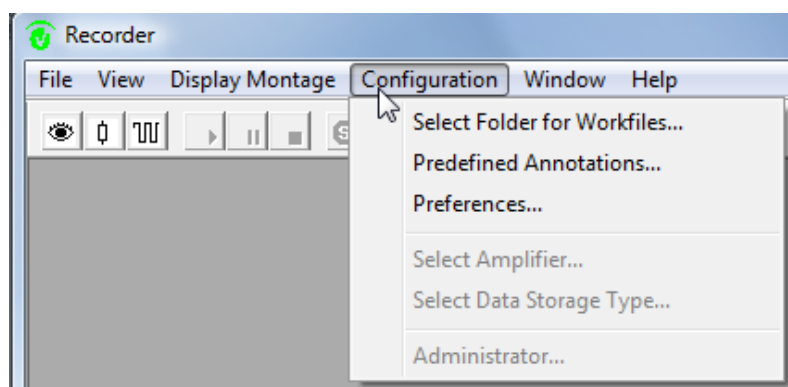


FIGURE 5—2 THE MENU ITEM FOR SELECTING THE AMPLIFIER IS GRAYED OUT IN NORMAL USER MODE

After you have first installed the software, a dialog box appears in which you can select an EEG amplifier:

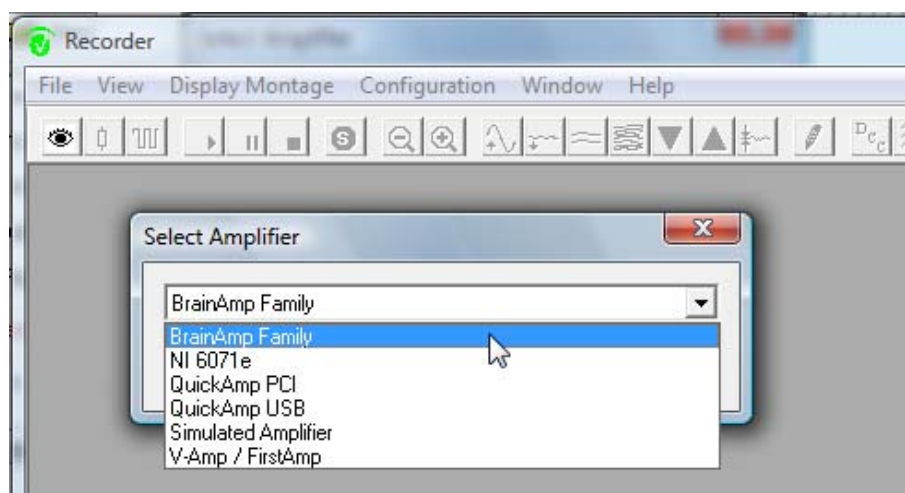


FIGURE 5—3 SELECTING THE AMPLIFIER



Make sure that you have Administrator privileges. If you do not have administrator privileges, you cannot access the function for selecting the amplifier.

The Recorder makes default settings for your EEG amplifier. To check that your EEG amplifier is working properly, first make sure that the amplifier is connected to your PC correctly and is switched on. In the toolbar, click the **Monitor**  button. To close monitoring mode, click the **Stop Monitoring**  button in the toolbar. (The program switches to idle mode.)

If no errors are encountered, EEG curves appear in the workspace running from left to right.



FIGURE 5—4 REPRESENTATION OF EEG CURVES

If the message “The setup does not match the amplifier’s capabilities!” appears, the current amplifier settings are not compatible with the amplifier you have selected. To eliminate this problem, follow the instructions for setting up a workspace given in section 5.3.



## 5.2 The Recorder interface

The menu bar and the toolbar are located at the top of the window.

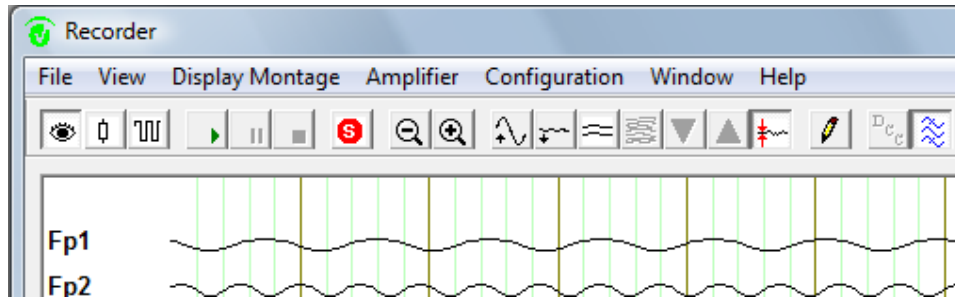


FIGURE 5—5 MENU BAR AND PORTION OF THE TOOLBAR

The individual menus have the following functions:

- The **File** menu is used to set up and edit a workspace;
- **View** is used to show and hide the status bar;
- **Display Montage** is used to display and edit the montages;
- **Amplifier** contains amplifier-specific settings and settings for the test signal;
- **Configuration** is used to make default settings for the locations used to archive and store the work files and the data, to configure administrative rights and preferences and to select the amplifier used;
- **Window** is used to configure the data window;
- **Help** provides access to the online Help system for the Recorder.

The toolbar is located below the menu bar and allows you to make a number of different settings, including the time period displayed and the number of channels displayed simultaneously.

The labels for the elements in the toolbar are displayed when you position the mouse pointer over each element. A tool tip appears after a few moments. (The status bar at the bottom of the workspace contains additional brief information on the elements.)

The toolbar contains the following elements:

-  **Monitor** is used to view the EEG data;
-  **Impedance Check** performs the impedance measurement;
-  **Test Signal:** You can view and save test signals using this button if the amplifier which is connected allows you to do so;
-  **Start/Resume Recording** starts or resumes recording;

A dialog box opens in which you can enter a comment. This comment is saved in the EEG file. A filename is proposed which you can either accept or change.

-  **Pause Recording** pauses the recording. While the recorder is in pause mode, you can measure the impedance without closing the EEG file.
-  **Stop Recording** stops the recording. To resume recording, click the Start button;
-  **Stop Monitoring** closes monitoring mode. Note that you can only close the program when you have explicitly stopped the recording and then closed monitoring mode by clicking the **Stop Monitoring** button.

You can save the test signals in the current EEG file. You will find detailed information on the form and size of the test signal in chapter 8;

-  **Increase Interval** increases the time interval displayed (alternatively use the keyboard shortcut **<Ctrl-(-)>**);
-  **Decrease Interval** decreases the time interval displayed (alternatively use the keyboard shortcut **<Ctrl-(+)>**);
-  **Scale Up** increases the scale (sensitivity) (alternatively use the keyboard shortcut **<Ctrl - ↑>**).

To use different scales for individual channels (e.g. ECG channels), you can assign different scaling factors to each channel. For further information, see section 7.2;

-  **Scale Down** decreases the scale (sensitivity) (alternatively use the keyboard shortcut **<Ctrl - ↓>**)
-  **Decrease Channels** decreases the number of channels displayed;
-  **Increase Channels** increases the number of channels displayed;

-  **Next Group** switches to the next channel group. This function is only available if you have already reduced the number of channels;
-  **Previous Group** switches to the previous channel group. This function is only available if you have already reduced the number of channels;
-  **Baseline Correction in Display** activates or deactivates baseline correction. When activated, only the baseline of the representation is shown, and not the actual data.
-  **Annotation** allows you to enter a free text (alternatively use the keyboard shortcut **Ctrl-A**).
-  **DC Correction** activates or deactivates DC offset correction for the DC amplifier (alternatively use the keyboard shortcut **Ctrl-D**). DC offset correction acts directly on the data.

The **DC Correction** button only appears in the toolbar if you are using a BrainAmp DC, BrainAmp MR plus or BrainAmp ExG.



-  **Display Filter** activates or deactivates the filters. You can toggle this button during monitoring or recording.
- The preset value for this function can be found in the **New Workspace/Edit Workspace** dialog box, on the third page **Software Filters**, on the **Display Filters** tab and the **Enable Filters** check box.
- If you change the setting (filter on/off) by clicking this button, the Recorder retains the corresponding status, even if you interrupt and resume monitoring and data storage. The workspace file is not changed, and if you close the Recorder, the old workspace is opened with the setting you have made when the Recorder is restarted.
-  **Show Workspace Info** shows the configuration of the current workspace. The information contains all the settings made when editing the workspace except for the settings made on the first page of the dialog box **Edit Workspace – Data Files Settings**.
-  **Cascade Windows** arranges all open windows on top of each other;
-  **Tile Windows** arranges the windows next to each other;
-  **Tile Windows** arranges the windows one above the other;
-  **About** contains version information and information on the connected dongle.

The status bar at the bottom of the window is made up of the following sections:

- **Monitoring** The first section shows the current status of the program (or the operating mode), for instance “Monitoring”, “Saving”, etc.).
- **Standard Montage** The second section shows the type of montage used. For information on montages, see section 6.3.
- **BrainAmp\_0008.eeg** The third section shows the name of the currently open EEG file.
- **Elapsed Time: 00:00:20** The fourth section shows the elapsed recording time of the currently open EEG file.
- **Free Space: 801:08:59** The fifth section shows the amount of free hard disk space in hours. This information is only available when an EEG file is open.
- **Buffer: 1%** The sixth section shows the utilization of the internal data buffer as a percentage.
- **Battery 5.5 V** If you are using an amplifier from the BrainAmp family, the following section shows a battery symbol indicating the battery voltage of the connected EEG amplifier. The charge level of the battery is indicated by the color (green, yellow, red). If the battery is shown in red, you should replace it.
- **BrainCap32 workspace** The final section of the status bar contains the name of the current workspace.

The left-hand pane (Monitoring window) contains recorded raw EEG data or shows a dynamic display of the raw data. The right-hand view contains the segmentation or average groups. You can use the tabs to switch between the individual groups.

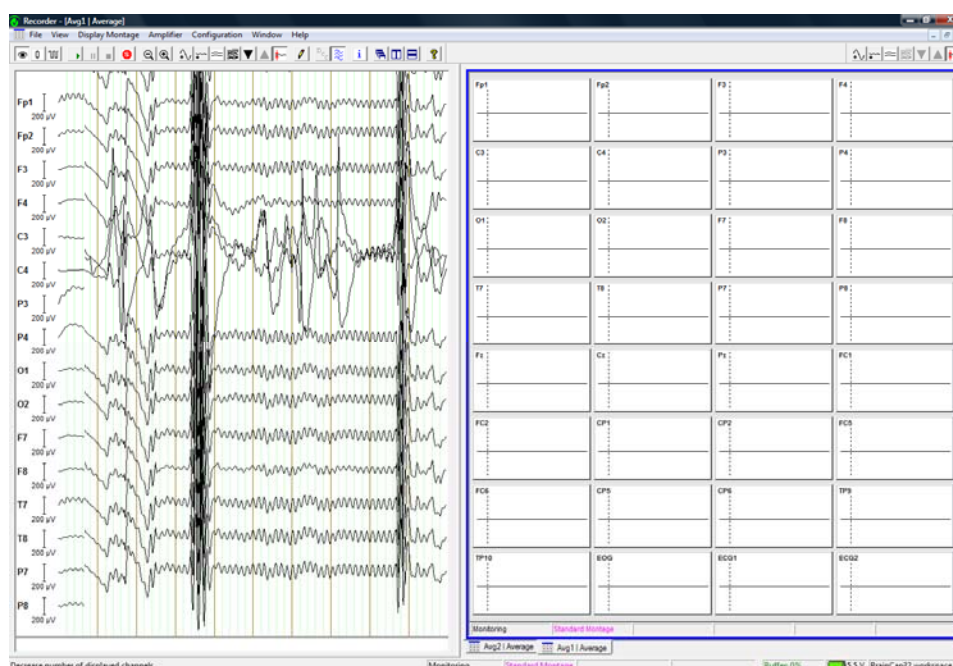


FIGURE 5—6 RECORDER INTERFACE WITH A TWO-PANE VIEW

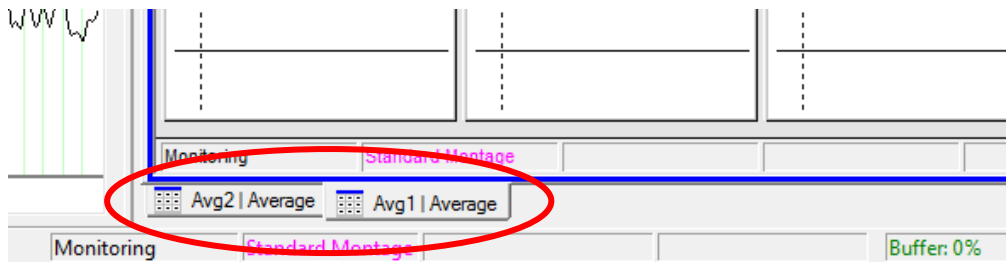


FIGURE 5—7 TAB FOR SWITCHING BETWEEN SEGMENTATION OR AVERAGE GROUPS

The channel names are shown on the far left of the workspace. The percentages shown on the image for each channel only appear if a DC amplifier is connected in DC recording mode. In this event, the values correspond to the DC offset of the signal. An offset of 100% corresponds to saturation at the positive end of the recording level range. An offset of -100% corresponds to saturation at the negative end of the recording level range.

At the bottom of the channel list there is a scaling bar that enables you to assess the signal size. If fewer channels are displayed and there is enough space, a scaling bar is shown in front of every channel.

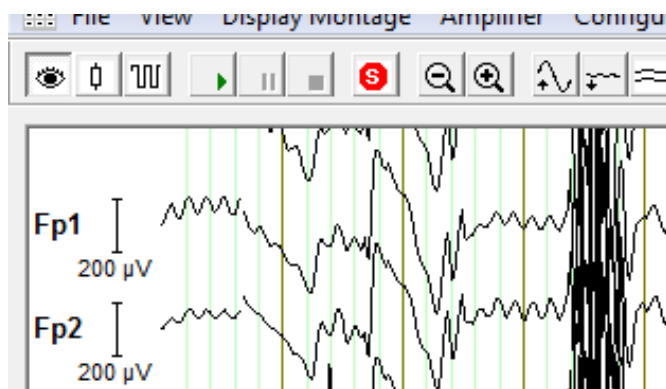


FIGURE 5—8 CHANNEL NAMES DISPLAYED WITH SCALING BAR

Beneath the EEG curves, separated by a gray line, the program displays time markers from the amplifier's digital input.



## 5.3 Setting up a workspace

### 5.3.1 Settings for files and folders

Setting up a workspace allows you to define the user-specific recording parameters. The workspace stores the location at which the EEG files are stored, amplifier settings and other information.

The first time the Recorder is started, it creates a default workspace.

You can also create a new workspace by choosing **File > New Workspace....** You load an existing workspace by choosing **File > Open Workspace....**

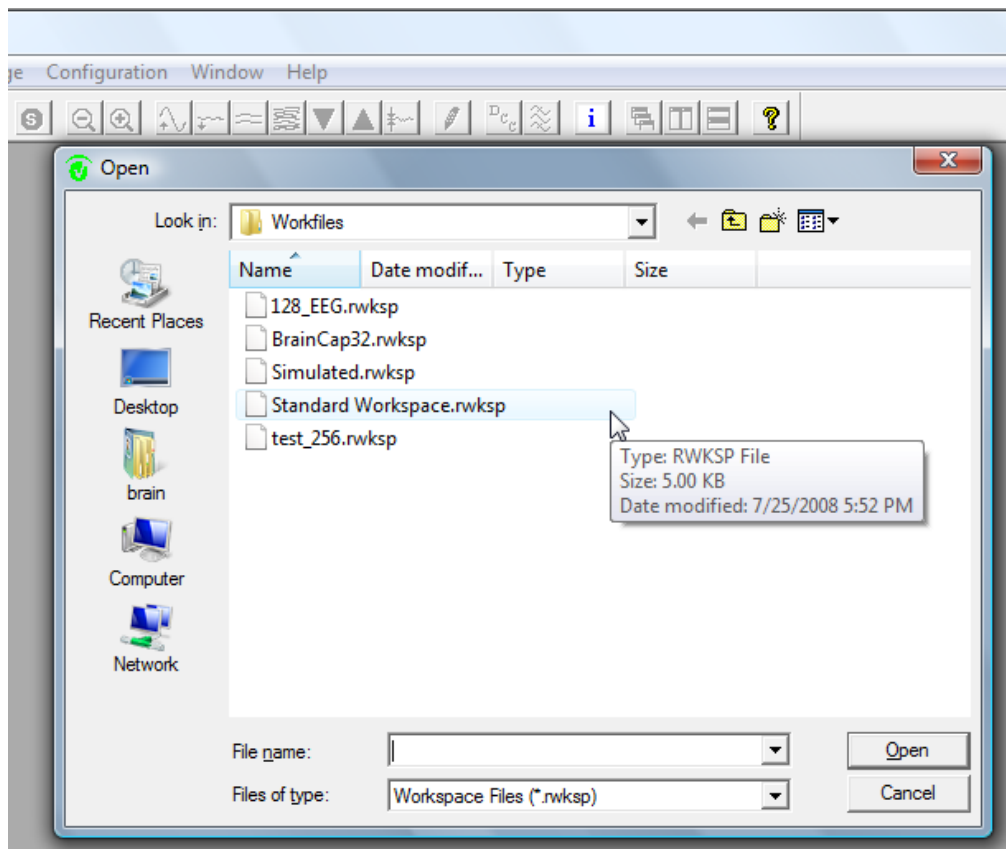


FIGURE 5—9 OPENING AN EXISTING WORKSPACE

If you wish to modify a workspace, choose **File > Edit Workspace....** The **Edit Workspace – Data Files Settings** dialog box appears.



The following descriptions also apply if you select **File > New Workspace....**

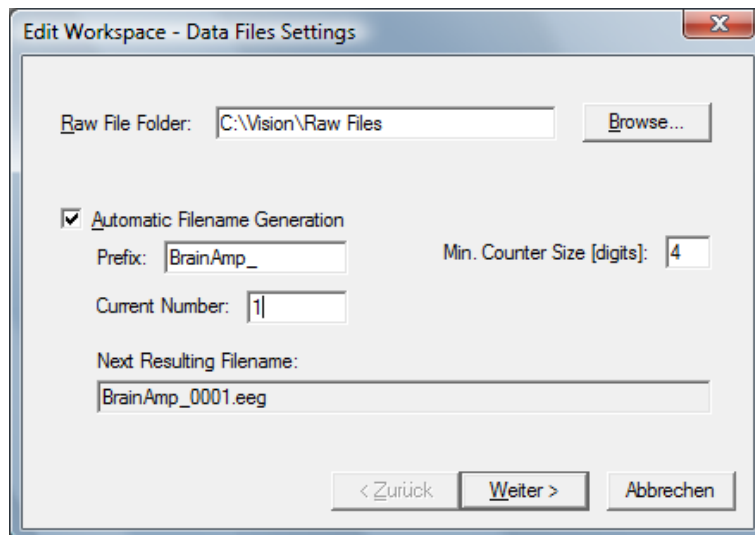


FIGURE 5—10 EDITING A WORKSPACE, PAGE 1 “DATA FILES SETTINGS”

The **Raw File Folder** field is used to specify where the raw EEG data is stored. You can select the folder by clicking the Browse button.

If you check **Automatic Filename Generation**, the name of the raw data set is generated automatically on the basis of a **Prefix**, to which a sequential number **Current Number** is appended. The file for the first recording could therefore be BrainAmp\_0001.eeg, in which case the name of the second file would be BrainAmp\_0002.eeg.

The **Min. Counter Size [digits]** field specifies the minimum number of digits that appear in the name of the data set. The number specified must be between 4 and 10.

The **Next Resulting Filename** field shows the file name that results from the entries you have made.

Click the **Next** button to proceed to the second page of the workspace dialog box **Edit Workspace – Amplifier Settings**.



The second page contains amplifier-specific parameters. These are described below using the BrainAmp as an example. You will find further information on the individual EEG amplifiers and accessories (QuickAmp, V-Amp, FirstAmp and Simulated Amplifier; National Instruments A/D converter board) in chapter 8 “Amplifier-specific properties”.

### 5.3.2 Amplifier-specific settings: Description using the BrainAmp as an example

Before you specify the settings you require, connect all amplifiers used and click the **Scan for Amplifiers** button.

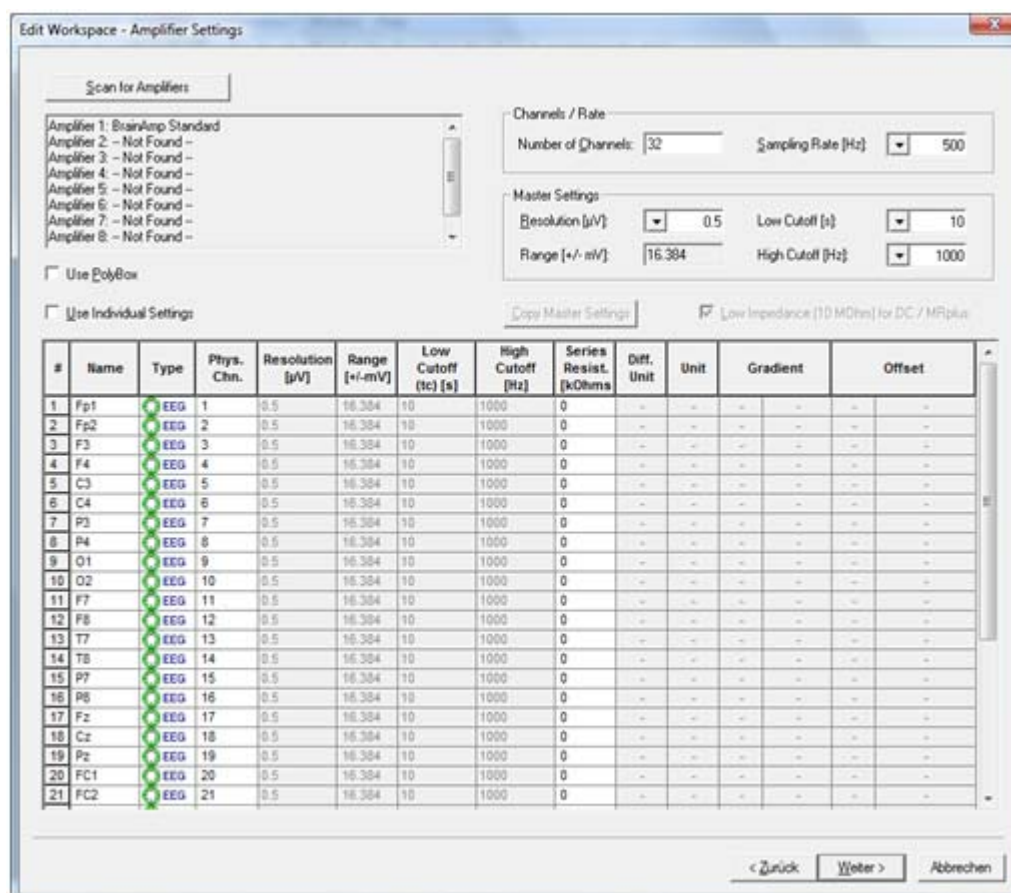


FIGURE 5—11 EDITING A WORKSPACE, PAGE 2 “AMPLIFIER SETTINGS” FOR THE BRAINAMP

Note that the functions for selecting an amplifier and for inserting and deleting channels are only available in the dialog box for amplifiers of the BrainAmp family.



At the top of the dialog box, click the **Scan for Amplifiers**.

SELECTING AN  
AMPLIFIER

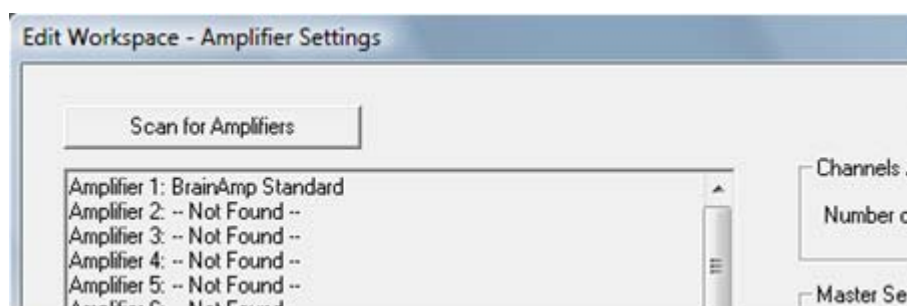


FIGURE 5—12 SELECTING AN AMPLIFIER FROM THE BRAINAMP FAMILY

“CHANNELS / RATE”  
GROUP BOX

Enter the number of channels in the **Number of Channels** field. Choose the sampling rate in the **Sampling Rate [Hz]** field.

“MASTER SETTINGS”  
GROUP BOX

Choose the amplitude resolution from the **Resolution [μV]** field. The value in the **Range [+/- mV]** field specifies the range across which the amplifier sends data to the recorder.

Specify the high and low cutoff filters in the **Low Cutoff [s]** and **High Cutoff [Hz]** fields.

The **Low Impedance (10 MOhm) for DC / MRplus** check box allows you to switch the input impedance from above 100 MΩ to 10 MΩ if you are using a BrainAmp DC or BrainAmp MR plus.



Note that the parameters and the permitted ranges listed above depend on the EEG amplifier you have selected.

If your amplifier permits individuals settings to be made for each channel, you can check the **Use Individual Settings** box. This allows you to make the relevant settings separately for each channel in a table. The **Copy Master Settings** button allows you to copy the parameters you have entered into the table so that you only have to edit those channels for which the settings are different.

INSERTING AND  
REMOVING CHANNELS

If you wish to insert a channel in the channel table or remove a channel from the channel table, right-click in the relevant row. This opens a menu. The first two entries of this menu allow you to insert or remove a channel without changing the name and number of the physical channel for the subsequent channels. If you wish to update the names and numbers of the subsequent channels, choose **Insert/Remove Channel and Update All Following Physical Channels**.

| #  | Name | Type | Phys. Chn. | Resolution [μV] | Range [+/-mV] | Low Cutoff (tc) [s] | High Cutoff [Hz] | Series Resist [kOhm] |
|----|------|------|------------|-----------------|---------------|---------------------|------------------|----------------------|
| 1  | 1    | EEG  | 1          | 0.1             | 3.2768        | DC                  | 250              | 0                    |
| 2  | 2    | EEG  | 2          | 0.1             | 3.2768        | DC                  | 250              | 0                    |
| 3  | 3    | EEG  | 3          | 0.1             | 3.2768        | DC                  | 250              | 0                    |
| 4  | 4    | EEG  | 4          | 0.1             | 3.2768        | DC                  | 250              | 0                    |
| 5  | 5    | EEG  | 5          | 0.1             | 3.2768        | DC                  | 250              | 0                    |
| 6  | 6    | EEG  | 6          | 0.1             | 3.2768        | DC                  | 250              | 0                    |
| 7  | 7    | EEG  | 7          | 0.1             | 3.2768        | DC                  | 250              | 0                    |
| 8  | 8    | EEG  | 8          | 0.1             | 3.2768        | DC                  | 250              | 0                    |
| 9  | 9    |      |            |                 |               |                     |                  |                      |
| 10 | 10   |      |            |                 |               |                     |                  |                      |
| 11 | 11   |      |            |                 |               |                     |                  |                      |
| 12 | 12   |      |            |                 |               |                     |                  |                      |
| 13 | 13   |      |            |                 |               |                     |                  |                      |
| 14 | 14   |      |            |                 |               |                     |                  |                      |
| 15 | 15   | EEG  | 15         | 0.1             | 3.2768        | DC                  | 250              | 0                    |

FIGURE 5—13 INSERTING AND REMOVING CHANNELS, BRAINAMP FAMILY

Click the **Insert** command to insert a channel. The physical channel index of the subsequent channels is incremented automatically. The focus is set to the empty channel name and the remaining cells are filled with default values. The channel type is filled in automatically on the basis of the physical channel index.

**Remove** is used to remove a channel. When you choose this command, you are asked to confirm whether you really want to remove the channel. The command is not available if the table only contains one channel.

The table allows you to make the following settings:

- Enter the channel name in the **Name** column.

If you enter the same name twice, an error message appears when you click **Next** at the bottom of the dialog box. This considerably facilitates reconfiguration of the workspace. The function is not, however, available for QuickAmp PCI, NI 6071e A/D converter board and Simulated Amplifier.

- The **Type** column specifies the channel type (EEG, BIP, AUX).
- The **Phys. Chn.** column allows you to assign physical channels to the logical channels in the first column provided that your amplifier permits this. Assignment of the channels in this way makes sense, for instance, if you are working with an electrode cap but only wish to work with selected electrodes of the cap.
- The **Resolution [ $\mu$ V]** column contains the signal resolution.
- The **Range [ $\pm$  mV]** column contains the range across which the amplifier sends data to the Recorder.
- The **Low Cutoff (tc) [s]** column allows you to specify the low cutoff filter.
- The **High Cutoff [Hz]** column allows you to specify the high cutoff filter.
- In the **Series Resist. [kOhms]** column, enter the resistance of the protective resistors fitted in the electrode cables. These are only required for the BrainAmp MR amplifier or if you are using an electrode cap for derivation that is fitted with resistors (e.g. MRI caps (BrainCap MR) and bipolar electrodes used in MRI scanners). The series resistances are saved in the workspace. These resistance values are subtracted from the measured impedances during impedance measurement, so that only the impedance between the skin and the electrodes is shown in the Impedance Check view and saved in the header.

For all amplifier families **except** the Simulated Amplifier you are prompted to save the edited workspace after you have finished editing. By default, the workspace to be saved has the same name as the active workspace. If you do not change this name, the following warning is issued “???.rwksp already exists. Do you want to replace it?” You can change the name of the workspace or confirm that the workspace is to be replaced. If you choose to replace the workspace, the old workspace is overwritten.

EDIT WORKSPACE – ALL  
AMPLIFIERS

### 5.3.3 Software filters

The Edit **Workspace – Software Filters** dialog box is used to set the filter parameters for the individual software filter paths. Three separate filter paths are available:

- Filtering of the raw data to be saved,
- Filtering of all data used for segmentation/averaging,
- Filtering of the displayed data.

You can apply this setting to the channels as a group or to individual channels by checking or unchecking the **Use Individual Settings** box. You can also deactivate the paths completely by unchecking the **Enable Filters** for each path.



Because the filters are software filters, you can enter any values. Nevertheless, you should take care not to set any frequencies with a value equal to or greater than half the selected sampling rate.

Raw Data | **Saving Filters** | Segmentation Filters | Display Filters

☒ **Enable Filters**

Master Settings

☒ **Low Cutoff Filter**  
Time Constant [s]: 0.3    Frequency [Hz]: 0.531

☒ **High Cutoff Filter**  
Frequency [Hz]: 70

☐ **Notch Filter**  
Frequency [Hz]: 50

☐ **Use Individual Settings**    Copy Master Settings

| Channel | Low Cutoff                          |                   |                | High Cutoff                         |                | Notch                    |                |
|---------|-------------------------------------|-------------------|----------------|-------------------------------------|----------------|--------------------------|----------------|
|         | Enable                              | Time Constant [s] | Frequency [Hz] | Enable                              | Frequency [Hz] | Enable                   | Frequency [Hz] |
| Fp1     | <input checked="" type="checkbox"/> | 0.3               | 0.531          | <input checked="" type="checkbox"/> | 70             | <input type="checkbox"/> | 50             |
| Fp2     | <input checked="" type="checkbox"/> | 0.3               | 0.531          | <input checked="" type="checkbox"/> | 70             | <input type="checkbox"/> | 50             |
| F3      | <input checked="" type="checkbox"/> | 0.3               | 0.531          | <input checked="" type="checkbox"/> | 70             | <input type="checkbox"/> | 50             |
| F4      | <input checked="" type="checkbox"/> | 0.3               | 0.531          | <input checked="" type="checkbox"/> | 70             | <input type="checkbox"/> | 50             |
| C3      | <input checked="" type="checkbox"/> | 0.3               | 0.531          | <input checked="" type="checkbox"/> | 70             | <input type="checkbox"/> | 50             |
| C4      | <input checked="" type="checkbox"/> | 0.3               | 0.531          | <input checked="" type="checkbox"/> | 70             | <input type="checkbox"/> | 50             |
| P3      | <input checked="" type="checkbox"/> | 0.3               | 0.531          | <input checked="" type="checkbox"/> | 70             | <input type="checkbox"/> | 50             |
| P4      | <input checked="" type="checkbox"/> | 0.3               | 0.531          | <input checked="" type="checkbox"/> | 70             | <input type="checkbox"/> | 50             |
| O1      | <input checked="" type="checkbox"/> | 0.3               | 0.531          | <input checked="" type="checkbox"/> | 70             | <input type="checkbox"/> | 50             |
| O2      | <input checked="" type="checkbox"/> | 0.3               | 0.531          | <input checked="" type="checkbox"/> | 70             | <input type="checkbox"/> | 50             |
| F7      | <input checked="" type="checkbox"/> | 0.3               | 0.531          | <input checked="" type="checkbox"/> | 70             | <input type="checkbox"/> | 50             |
| F8      | <input checked="" type="checkbox"/> | 0.3               | 0.531          | <input checked="" type="checkbox"/> | 70             | <input type="checkbox"/> | 50             |
| T7      | <input checked="" type="checkbox"/> | 0.3               | 0.531          | <input checked="" type="checkbox"/> | 70             | <input type="checkbox"/> | 50             |
| T8      | <input checked="" type="checkbox"/> | 0.3               | 0.531          | <input checked="" type="checkbox"/> | 70             | <input type="checkbox"/> | 50             |
| P7      | <input checked="" type="checkbox"/> | 0.3               | 0.531          | <input checked="" type="checkbox"/> | 70             | <input type="checkbox"/> | 50             |
| P8      | <input checked="" type="checkbox"/> | 0.3               | 0.531          | <input checked="" type="checkbox"/> | 70             | <input type="checkbox"/> | 50             |
| Fz      | <input checked="" type="checkbox"/> | 0.3               | 0.531          | <input checked="" type="checkbox"/> | 70             | <input type="checkbox"/> | 50             |
| Cz      | <input checked="" type="checkbox"/> | 0.3               | 0.531          | <input checked="" type="checkbox"/> | 70             | <input type="checkbox"/> | 50             |
| Pz      | <input checked="" type="checkbox"/> | 0.3               | 0.531          | <input checked="" type="checkbox"/> | 70             | <input type="checkbox"/> | 50             |
| FC1     | <input checked="" type="checkbox"/> | 0.3               | 0.531          | <input checked="" type="checkbox"/> | 70             | <input type="checkbox"/> | 50             |
| FC2     | <input checked="" type="checkbox"/> | 0.3               | 0.531          | <input checked="" type="checkbox"/> | 70             | <input type="checkbox"/> | 50             |
| CP1     | <input checked="" type="checkbox"/> | 0.3               | 0.531          | <input checked="" type="checkbox"/> | 70             | <input type="checkbox"/> | 50             |
| CP2     | <input checked="" type="checkbox"/> | 0.3               | 0.531          | <input checked="" type="checkbox"/> | 70             | <input type="checkbox"/> | 50             |

< Zurück    Weiter >    Abbrechen

FIGURE 5–14 SETTING THE SOFTWARE FILTERS

Click the **Next** button in the **Display Filters** tab to proceed to the **Segmentation / Averaging** page.

#### 5.3.4 Segmentation and averaging

The **Edit Workspace – Segmentation / Averaging** dialog box allows you to make optional settings for segmentation and averaging. The various options available for these settings are described in detail in section 6.4.

When you click **Finish**, a dialog box opens allowing you to save the workspace file. Give the file of meaningful name and press the **Enter** key or click **Save**.

Choose the command **File > Edit Workspace...** to modify the workspace. Choose the command **File > Open Workspace...** to load a workspace.

If you wish to use an existing workspace as a template for a new workspace, first load the existing workspace and then choose **File > New Workspace...**

You can view the parameters of the current workspace at any time – even during recording – by clicking the **Show Workspace Info**  button in the toolbar.

Further settings for the Recorder are described in chapter 7 “Program configuration”. Amplifier-specific properties such as test signal values and digital port settings are described in chapter 8 “Amplifier-specific properties”.





## 6 Functional description

### 6.1 Impedance measurement

If your EEG amplifier features built-in impedance measurement, you can carry out such measurements using the Recorder.

To do this, click **Impedance Check**  in the toolbar.

A top view of a representation of a head appears. A number of controls are located to the right of the view. If your electrodes are numbered after 10-10 or 10-20, they are shown automatically on the head. It is possible to show up to 256 standard positions.

If this is not the case, the electrodes are arranged at the top right of the workspace.

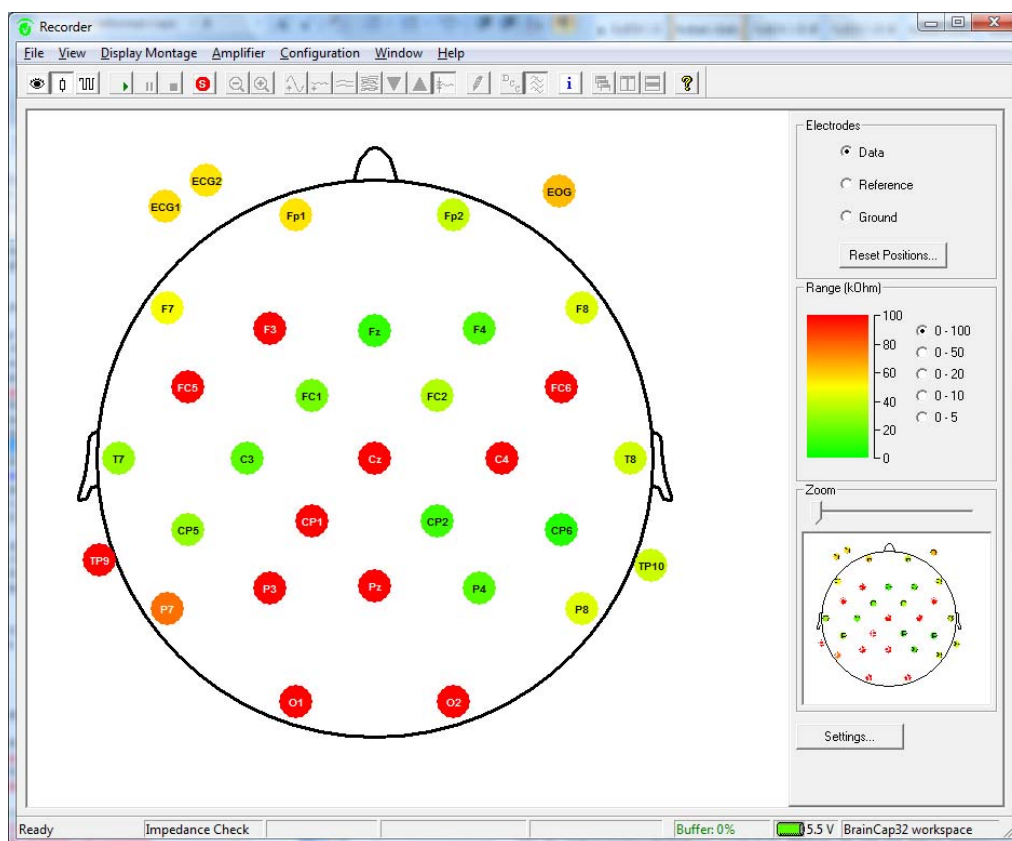


FIGURE 6—1 IMPEDANCE MEASUREMENT

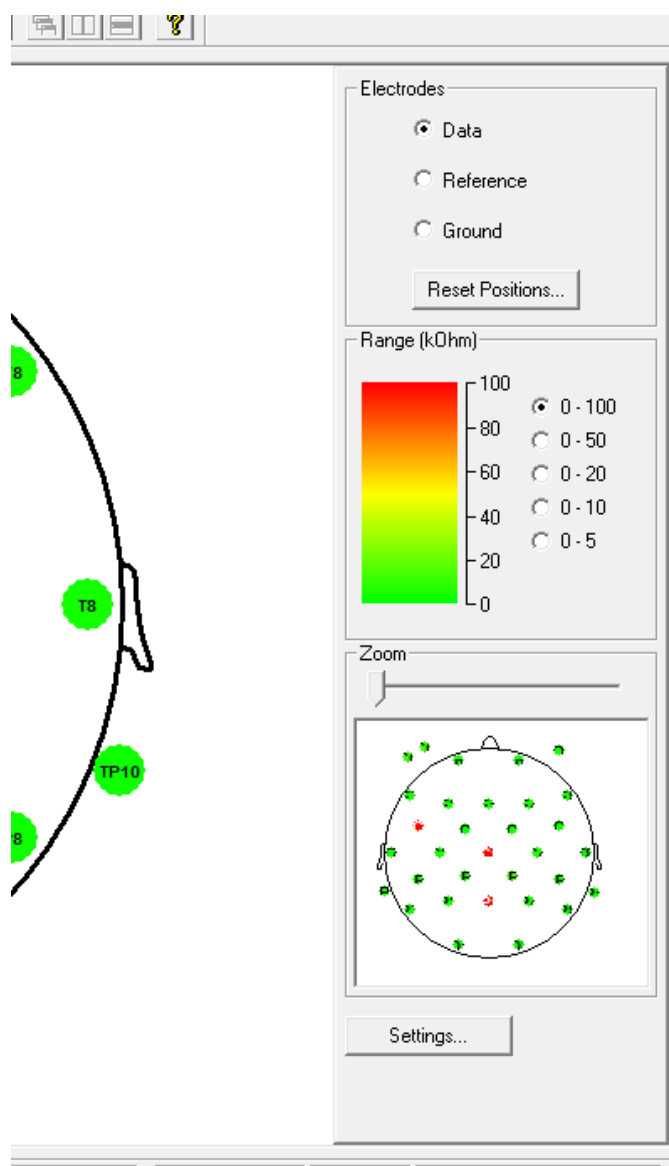


FIGURE 6—2 DETAILED VIEW OF CONTROLS

To change the position of the electrodes, left-click on an electrode, hold the mouse button down and move the electrode with the mouse.

The **Electrodes** group box allows you to select different electrode groups for which data is to be determined. The groups and their names depend on the amplifier you are using. Click the **Reset Positions** button to reset the electrodes to their initial positions.

Depending on the amplifier and the selected electrode group, you can configure different impedance ranges in the **Range (kOhm)** group box. The impedances of the electrodes are color-coded in accordance with the swatch.

If you are using a large number of electrodes, you can use the slider control in the **Zoom** group box to select the region of the head to be shown. The red square in the electrode view below defines the region shown in the main view. You can also move the square using the mouse.

Clicking the **Settings** button opens the **Impedance Check Settings** dialog box. Here you can define your own measurement ranges, the colors used, the color steps and an optional background bitmap.

**Impedance Check Settings**

OK Cancel

Ranges

Electrodes Group:

Data

| Ranges |                                     |             |             |
|--------|-------------------------------------|-------------|-------------|
| #      | Enabled                             | Min. [kOhm] | Max. [kOhm] |
| 1      | <input checked="" type="checkbox"/> | 0           | 100         |
| 2      | <input checked="" type="checkbox"/> | 0           | 50          |
| 3      | <input checked="" type="checkbox"/> | 0           | 20          |
| 4      | <input checked="" type="checkbox"/> | 0           | 10          |
| 5      | <input checked="" type="checkbox"/> | 0           | 5           |
| 6      | <input type="checkbox"/>            | 0           | 0           |
| 7      | <input type="checkbox"/>            | 0           | 0           |
| 8      | <input type="checkbox"/>            | 0           | 0           |
| 9      | <input type="checkbox"/>            | 0           | 0           |
| 10     | <input type="checkbox"/>            | 0           | 0           |

Impedance Color Coding

☒ Green, Yellow, Red

☐ Blue, Cyan, Green, Yellow, Red

☐ Black & White

☐ Discrete Color Steps

Number of Steps: 16

Electrode Label

Select Font... Reset Font

☒ Display Physical Channel Number

Background Image

☒ Use Bitmap

Name:

Browse...

FIGURE 6—3 SETTING THE MEASUREMENT RANGES AND COLORS

“RANGES” GROUP BOX For each electrode group, you can select up to ten measurement ranges in the **Ranges** group box.

“IMPEDANCE COLOR CODING” GROUP BOX The **Impedance Color Coding** group box allows you to define the color coding. You can choose between:

- A color gradient from green through yellow to red,
- A color gradient from blue through turquoise, green and yellow to red,
- A grayscale gradient from black to white.

Instead of a continuous color gradient between the minimum and maximum impedance value, you can change the colors in discrete steps. Do this by checking the **Discrete Color Steps** box. In addition, you can enter the number of color steps in the **Number of Steps** field.

“ELECTRODE LABEL” GROUP BOX Click the **Select Font** button to open a dialog box in which you can select the font used. The selected font is saved in the current workspace. Click **Reset Font** to reset the settings you have made to the default settings.

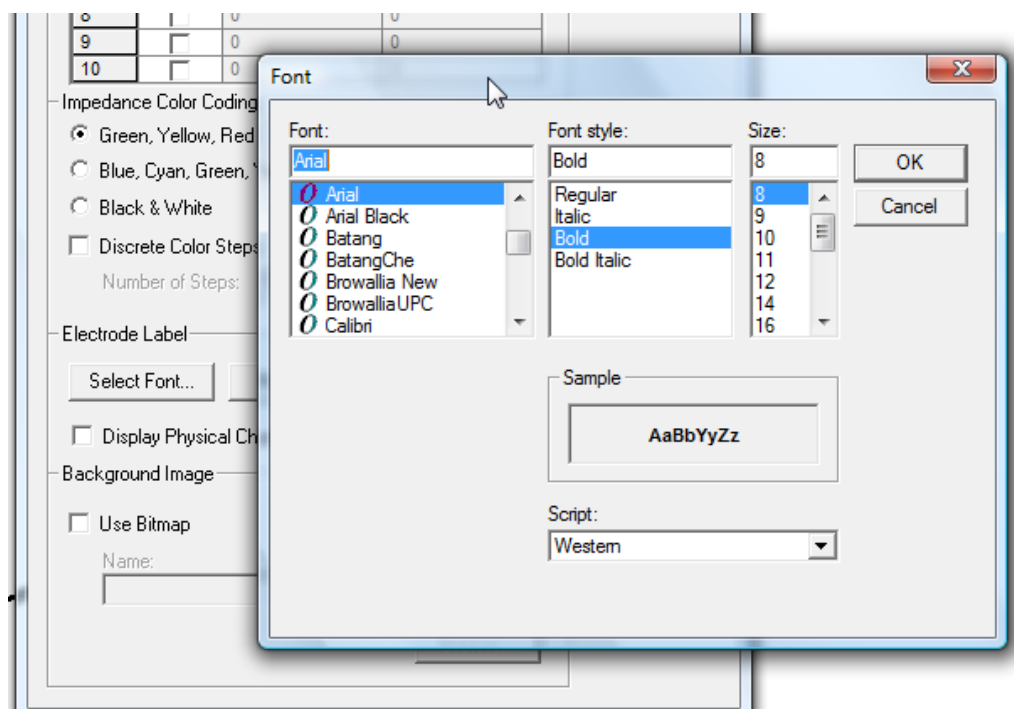


FIGURE 6–4 DEFAULT SETTINGS FOR THE FONT

If you check the Display Physical Channel Number box, the numbers of the physical channels are also displayed in addition to the position. This setting is saved in the current workspace.



All amplifier families **except** QuickAmp PCI support this function.

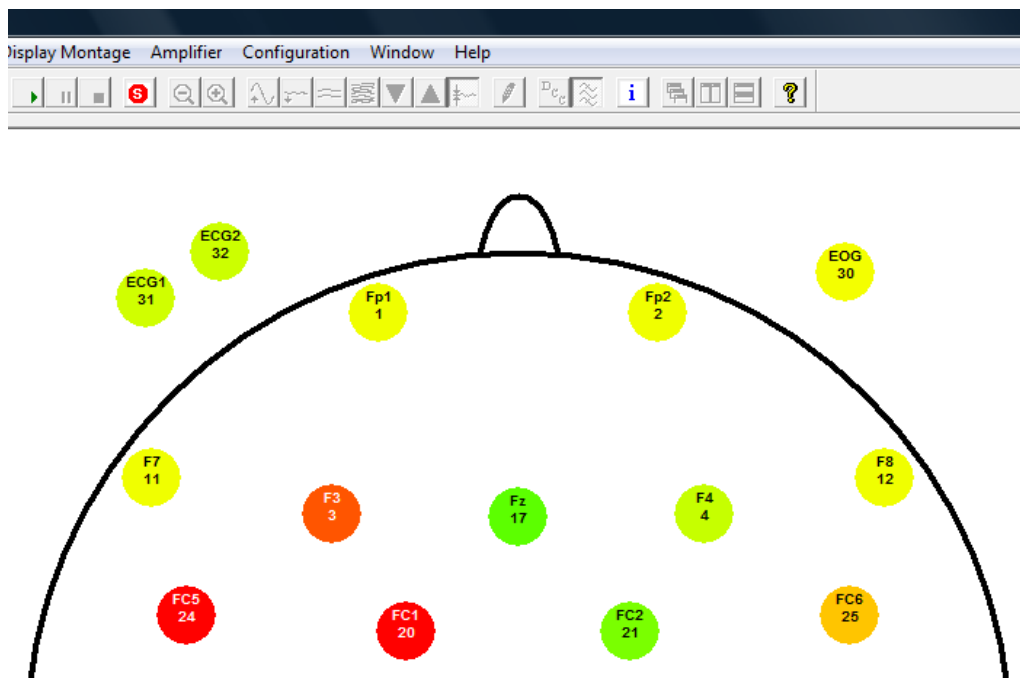


FIGURE 6—5 DISPLAYING THE POSITION AND NUMBERS OF THE PHYSICAL CHANNELS

Note that the font size is not automatically adjusted in zoom mode.



You can replace the default background (representation of a head) by any bitmap image. To load the bitmap file, check the **Use Bitmap** box.

“BACKGROUND IMAGE”  
GROUP BOX

Note that you can move the electrode positions on the horizontal plane, because the default background uses an “isotropic” representation. This means that any changes to the ratio between the height and width of the display window are ignored and the head remains round. In contrast to this, the bitmap always fills the entire window and the electrodes retain their relative positions on the bitmap.



If the bitmap file you have selected does not exist or if it has an invalid format, the standard background is used automatically.

Click the **Stop Monitoring**  button in the toolbar to stop impedance measurement. If you have changed the positions of the electrodes, the program prompts you to save these changes. The electrode positions are assigned to the current workspace.

You can find further impedance measurement options for your amplifier in chapter 8 “Amplifier-specific properties”.



## 6.2 Functions for viewing and recording data

### 6.2.1 Entering comments

You have the option of adding comments to the recorded EEG. These are displayed as markers in the lower marker area and during recording (type: “Comment”). You can enter your comments as freely-definable text or as predefined text.

You enter a freely-definable text by clicking the **Annotation**  button. You can also use the keyboard shortcut **Ctrl-A**.

FREELY-DEFINABLE TEXT

The **Annotation** dialog box opens and a marker with three question marks is added to the lower market area. Enter your text in the dialog box. This then replaces the question marks in the marker.

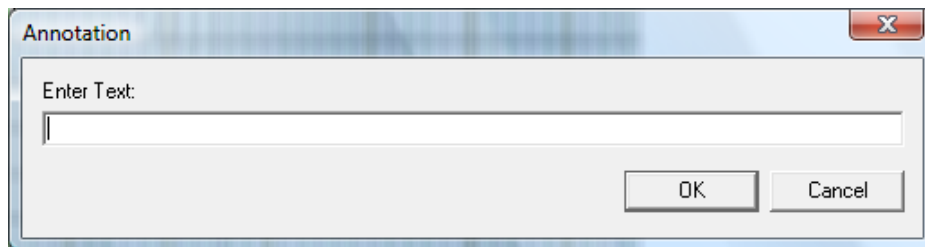


FIGURE 6—6 DIALOG BOX FOR ENTERING FREELY-DEFINABLE TEXT

You also have the option of pre-defining various texts. To use this option, close monitoring mode and choose **Configuration > Predefined Annotations....**

PREDEFINED TEXT

This opens the **Predefined Annotations** dialog box. In this dialog box, you can enter up to ten predefined texts. The predefined texts are displayed in the lower market area if you press the corresponding keys **1** through **0** in monitoring mode.

If this menu command is not available, the probable reason is that you do not have Administrator privileges. For further information, refer to section 7.1 “Configuring the user privileges” or contact your system administrator.



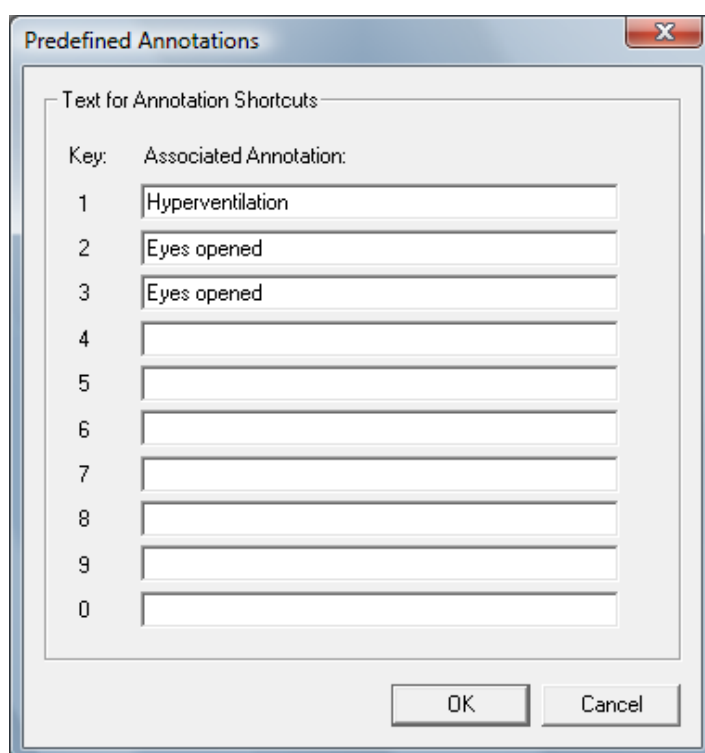


FIGURE 6—7 DIALOG BOX FOR ENTERING PREDEFINED TEXT

### 6.2.2 Blocking channels

To block a channel and thus suppress the signal received, right-click the corresponding channel name. This opens a context menu. Choose the **Switch Off Channel <channel name>** command. The corresponding channel is blocked, and the channel name and EEG curve are displayed in red.

To reactivate the channel, and repeat the process and choose the **Switch On Channel <channel name>** command.

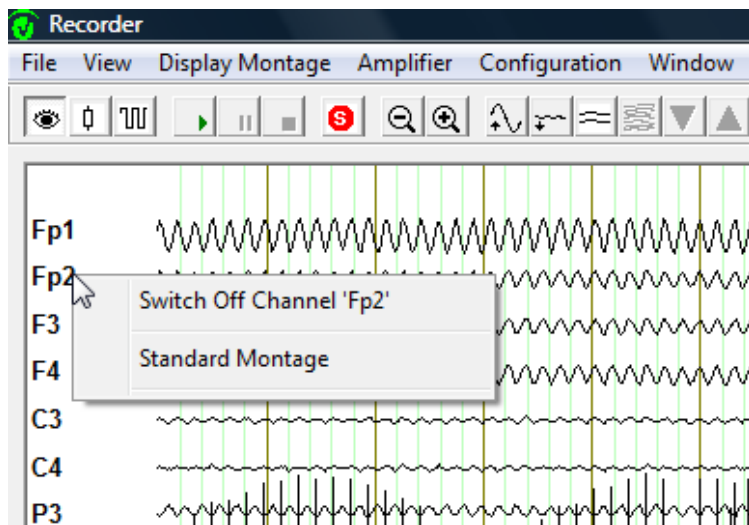


FIGURE 6—8 SUPPRESSING CHANNELS

### 6.2.3 DC offset correction

If you have a DC-coupled amplifier, then you can carry out DC offset correction with the Recorder. Do this by clicking the **DC Correction**  button. You can also use the keyboard shortcut **Ctrl-D**.



Performing a DC offset correction directly impacts the data. We therefore recommend that you try to avoid DC correction in important sections of the EEG.

The Recorder sets a DC correction marker to flag any DC correction in the data.

You can also configure the Recorder in such a way that DC correction is performed automatically as soon as a channel crosses a critical threshold. Do this by choosing **Configuration > Preferences**, and in the **DC Correction** tab, checking the **Automatic DC Correction** box and entering the required threshold.

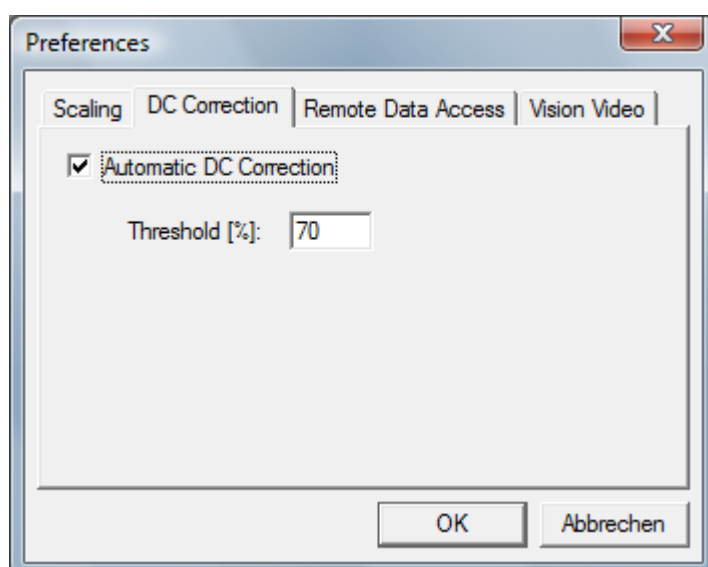


FIGURE 6—9 SETTING AUTOMATIC DC CORRECTION

## 6.3 Montages

Montages enable channels to be reconnected in the software, i.e. new voltage references are assigned to the channels.

Montages also serve to optimize the display of data, e.g. by combining frontal electrodes in one montage and occipital electrodes in another one. In this case, when a montage is selected, only those channels which have been assigned to it are displayed. The sequence of channels can also be changed in a montage so that channels which were originally apart can be shown next to each other. A channel can also be displayed multiple times in a montage.

A montage is used for visualization purposes only. The resulting data only exists temporarily and is not saved.

To create a new montage, choose **Display Montage > New....** The **New Montage** dialog box opens. This dialog box is used for determining the type of reference to be used in the new montage.

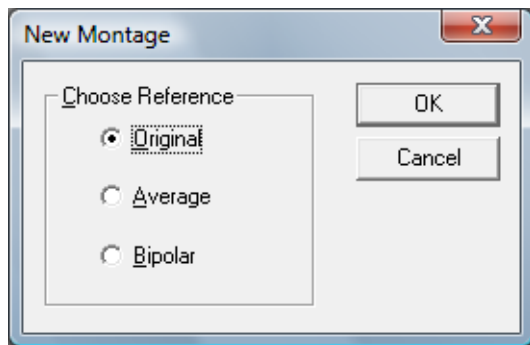


FIGURE 6—10 CREATING A MONTAGE

You can choose between three reference types: Original, Average and Bipolar:

- **Original:** No new reference is calculated. This type of montage is only used to group channels or optimize the way they are presented.
- **Average:** The average reference is calculated, i.e. the average of all selected channels is used as the reference.
- **Bipolar:** The differences between different channels are calculated for a bipolar connection.

To begin with, we recommend that you take the easiest reference type – the original reference.



Click **OK**. This takes you to the edit menu for electrodes. The edit menu is made up of two columns titled **Chn (+)** and **Chn (-)**. The columns specify the channels and their reference channels.

The second column cannot be referenced if you have selected any reference type other than Bipolar.



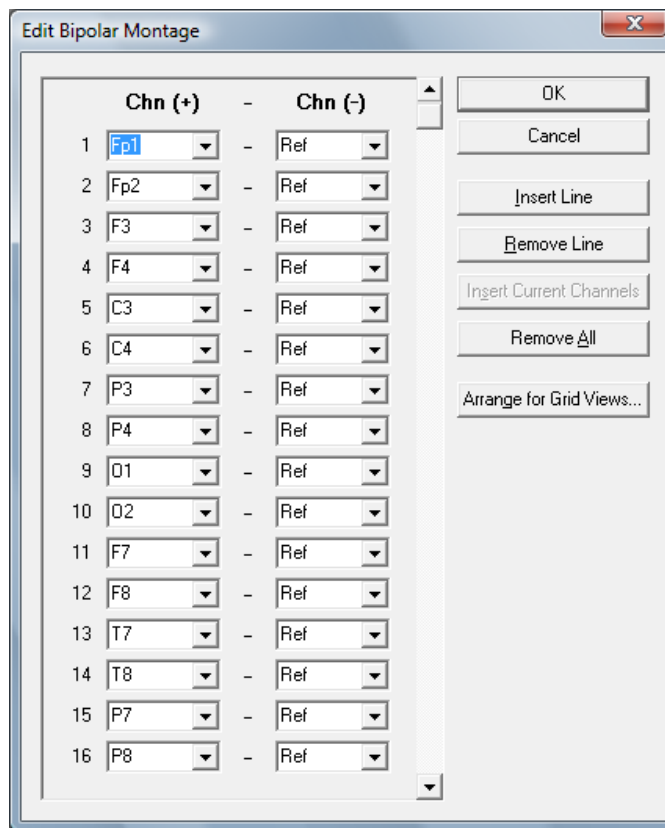


FIGURE 6—11 EDIT MENU FOR MONTAGES

In addition to the **OK** and **Cancel** buttons, the following functions are available on the right-hand side of the dialog box:

- **Insert Line** inserts a new line above the current line. The button becomes available as soon as you enter a text in the first field of the first channel.
- **Remove Line** removes the current line provided that it is not the last line.
- **Insert Current Channels** copies all the channels of the current setup into the montage in their original sequence. In some cases, it may now be quicker to build up the montage you require by removing and inserting individual channels, for instance. This button becomes available if the montage list is empty.
- **Remove All** removes the entire contents of a montage. You are prompted to confirm whether you wish this to be done. This button becomes available as soon as you have completed an entry.
- **Arrange for Grid Views...** opens a dialog box in which you can arrange the channels for the grid views. Grid views used when representing segmented or averaged data.

You can either enter the channel names manually or activate the selection menu and select a channel name from the list. When you have filled in the first 16 channels, you can reach the remaining channels at the bottom of the list by using the scroll bar.

If the montages are not bipolar, the program automatically fills the input fields for the reference channels with suitable names.

In the grid view used for representing segmented/averaged data, the channels are arranged in a grid. A preset pattern is used for the default montage. For other montages, you can use the **Arrange for Grid Views...** function to freely define the pattern. You have the option of defining the number of rows and columns you wish to use for the channel grid. Click the **Refresh** button to update the grid pattern that is shown. You can use the mouse to freely arrange the channels and the spaces between them.

GRID VIEW

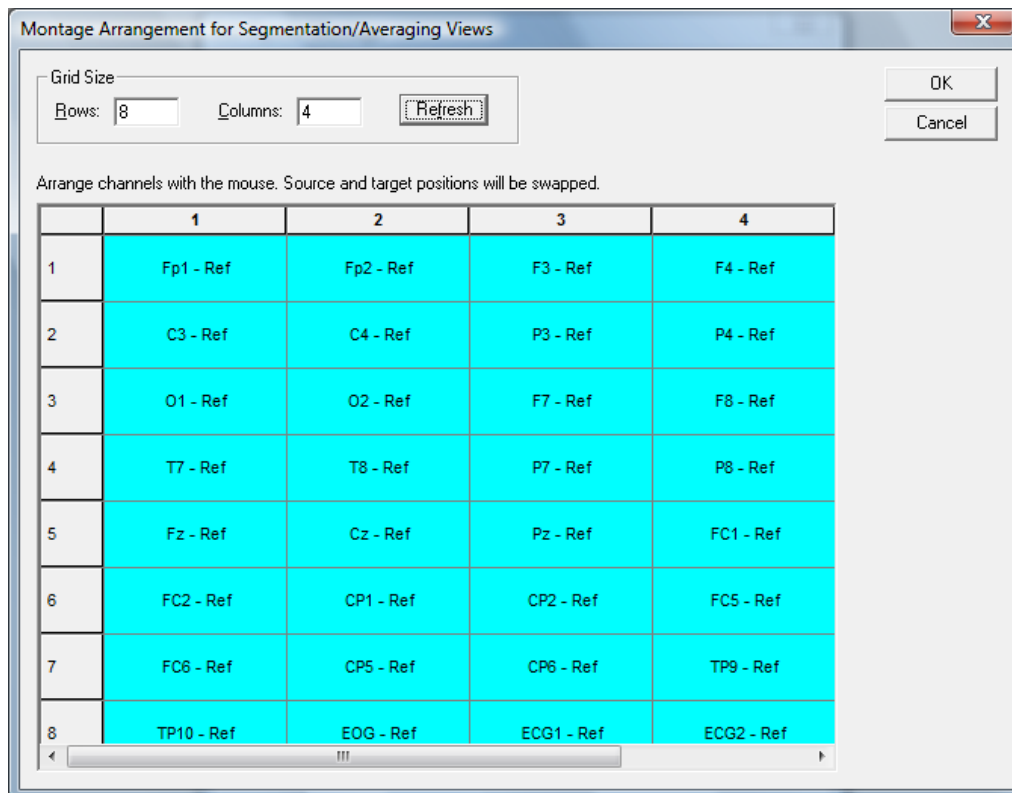


FIGURE 6—12 DEFINITION DIALOG BOX FOR THE GRID VIEW

To call your new montage, switch the Recorder to monitoring mode. Open the **Display Montage** menu. This menu has now been extended to include the name of your new montage. Choose your new montage. The EEG is displayed using the montage. To display the default montage again, simply call it from the **Display Montage** menu.

CALLING A MONTAGE

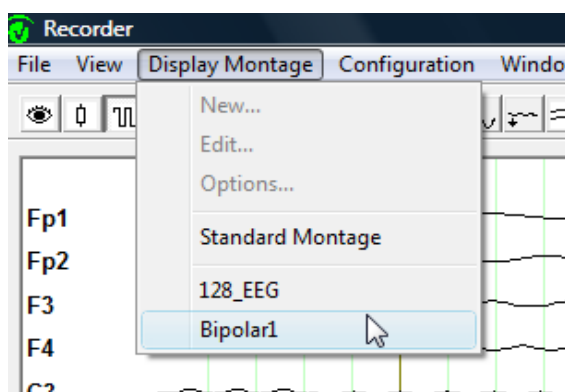


FIGURE 6—13 AUFRUFEN EINER ANGELEGTEN MONTAGE



If you have created a montage that does not contain any electrodes of the current setup, you cannot call this montage during monitoring.

#### MODIFYING THE MONTAGE

If you wish to modify an existing montage, select it with **Display Montage > Edit...** and then edit it. Please note that you cannot change the reference type of an existing montage. After you have edited the montage, the system prompts you to enter a name under which you wish to save the montage. You can enter a new name and thus derive a new montage from an existing one.

#### SWITCHING BETWEEN MONTAGES

You can assign specific keyboard shortcuts to montages to allow you to switch between them quickly. Pressing this keyboard shortcut activates the montages. Choose **Display Montage > Options...** to assign the montages to the keyboard shortcuts **Ctrl-1** through **Ctrl-0**. The shortcut **Ctrl-1** is reserved for the default montage. You can freely assign the remaining shortcuts to the existing montages.

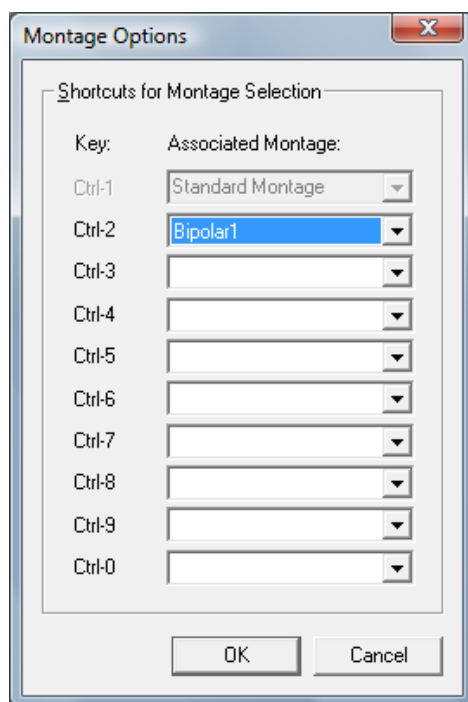


FIGURE 6—14 SELECTING KEYBOARD SHORTCUTS FOR MONTAGES

If you have defined one or more segmentation or averaging groups (see also section 6.4 “Segmentation and averaging”), you can use the keyboard shortcuts **Ctrl-Shift-1** through **Ctrl-Shift-0** to select the montage for the current group window in the same way.

Alternatively, you can call a new montage by right-clicking in a data window.

## 6.4 Segmentation and averaging

The Recorder can segment or average your data based on time markers such as stimulus markers or reaction markers.

Segmentation is always a preliminary step in averaging. Both procedures will therefore be presented together in this section.

You can save the segmented or averaged data in parallel with the raw data. You can also use segmentation and averaging to ascertain whether a visibly evoked potential is formed. In this case you do not store the segments or the average. It is also possible to save segmented data or the averaged data only, and to dispense with raw data.

We advise you to save raw data if possible. Only if you do this do you have the opportunity of changing the averaging parameters later.



### 6.4.1 Entering parameters

You can find the segmentation/averaging parameters under **File > New Workspace...** and **File > Edit Workspace...** on the third page of the dialog box.

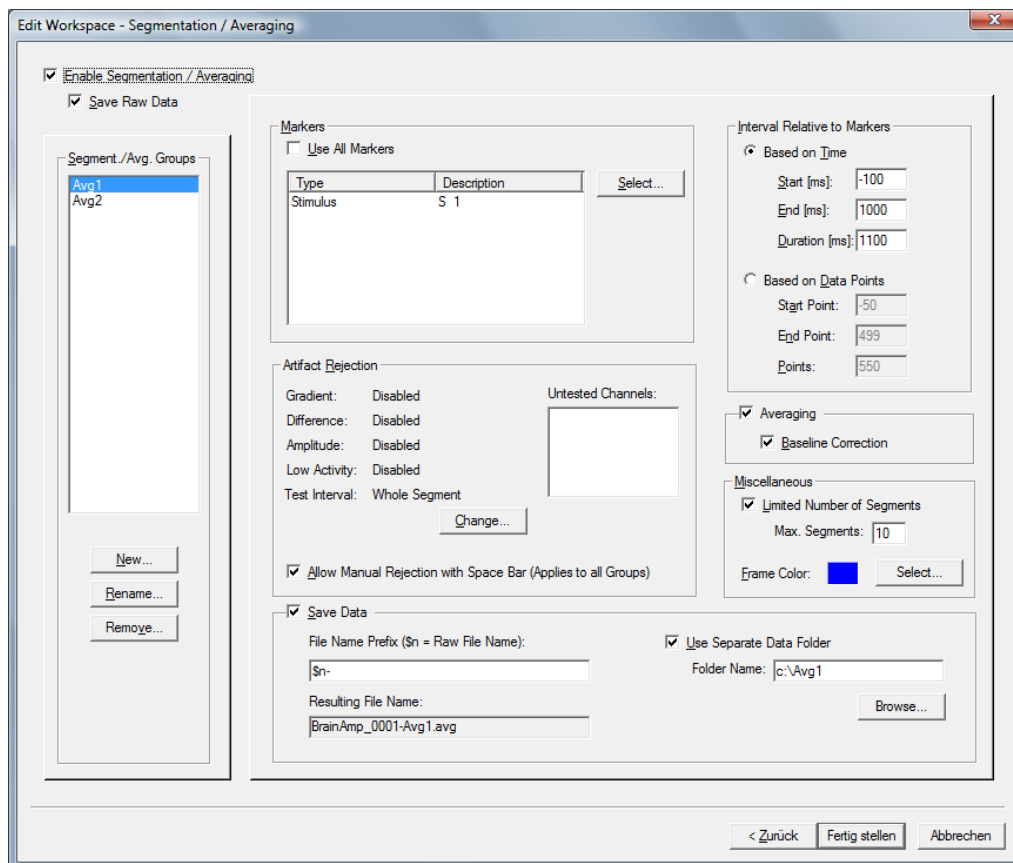


FIGURE 6—15 DIALOG BOX WITH SETTINGS FOR SEGMENTATION AND AVERAGING



You will find further information on pages 1 and 2 of this dialog box in section 5.3 “Setting up a workspace”.

In the **Edit Workspace – Segmentation/Averaging** dialog box, you will see the terms “segmentation group” and “averaging group”. A segmentation group describes segmentation based on one or more markers.

You can define the averaging parameters for each group separately. The data for each group is displayed in a separate window during operation and can optionally be stored in separate files. You can define a total of up to 16 groups.

### SETTINGS IN THE DIALOG BOX

You can make the following settings:

To begin with, activate or deactivate the segmentation/averaging option by checking the **Enable Segmentation/Averaging** box.

The **Save Raw Data** function allows you to define whether the raw data is to be stored in addition to the segmented/averaged data.

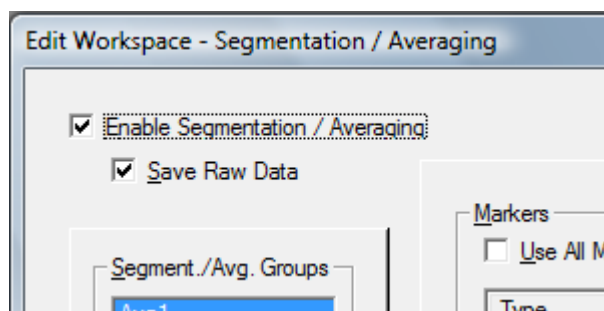


FIGURE 6—16 ACTIVATING/DEACTIVATING SEGMENTATION/AVERAGING AND STORAGE OF THE RAW DATA

The **Edit Workspace – Segmentation/Averaging** dialog box is divided into two functional blocks. The left-hand block contains the **Segment./Avg. Groups** group box, which is used to select, create, rename and delete groups. The right-hand block contains several group boxes and is used to display the parameters for the selected group.

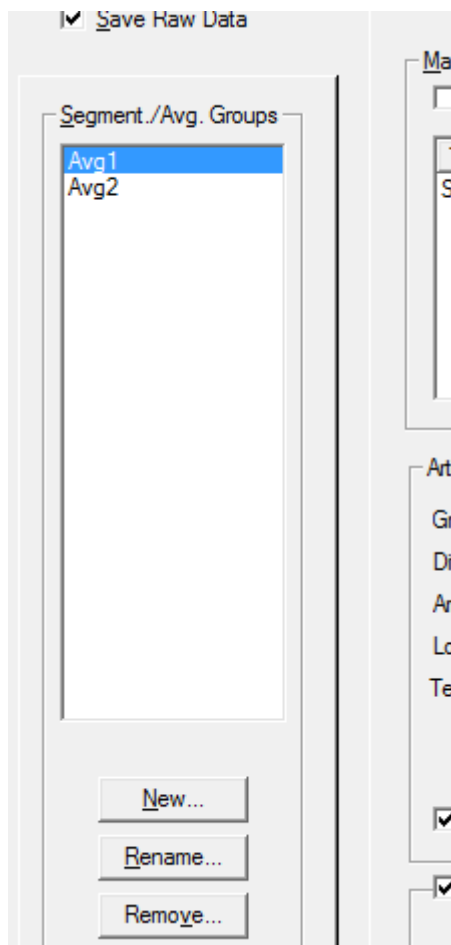


FIGURE 6—17 DEFINING GROUPS

The **Segment./Avg. Groups** group box contains a list that allows you to select a group for editing.

“SEGMENT./AVG.  
GROUPS” GROUP BOX

Click **New** to create a new group. This opens the **New Segmentation Group** dialog box. Enter the name of the group. Under **Copy Settings from Group** it is also possible to copy the settings from an existing group.

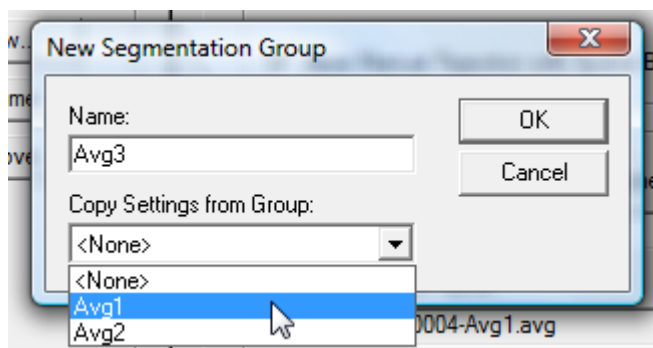


FIGURE 6—18 CREATING A NEW GROUP

The **Rename...** function allows you to rename the current group.

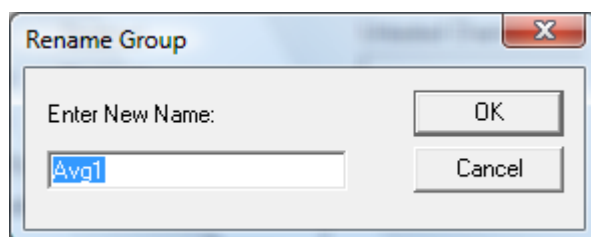


FIGURE 6—19 RENAMING A GROUP

The **Remove...** function allows you to delete the current group.

#### “MARKERS” GROUP BOX

The **Markers** group box allows you to select the markers that describe the relevant segments for the current group.

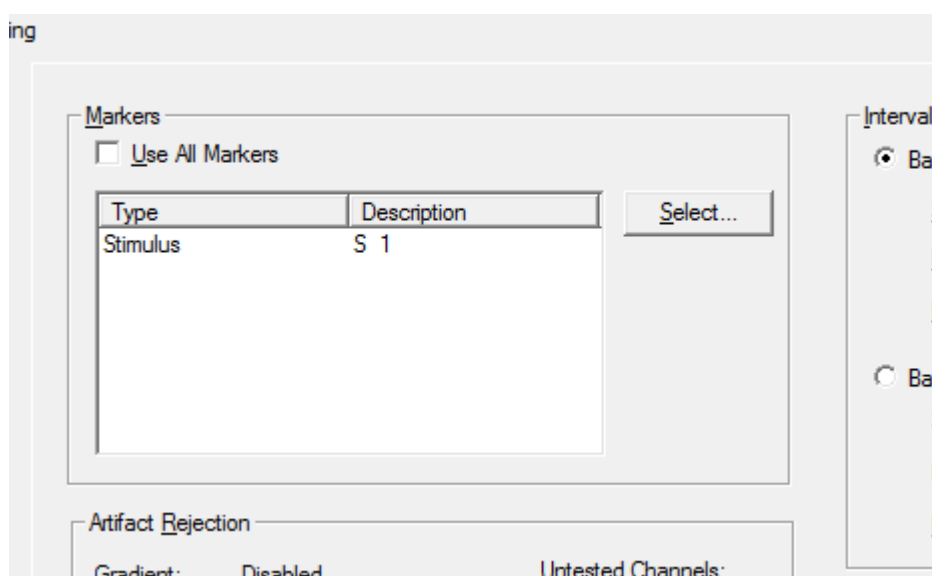


FIGURE 6—20 GROUPBOX MARKERS

If you check the **Use All Markers** box, all the markers sent by the EEG amplifier are used during segmentation/averaging.

Otherwise, those markers are used that are listed with their type and description.

If you wish to modify the marker list, click **Select**. A dialog box opens in which you can select various markers. To start with, choose the marker type from the left-hand selection list **Types**. Then select one or more markers from the middle list **Descriptions**.

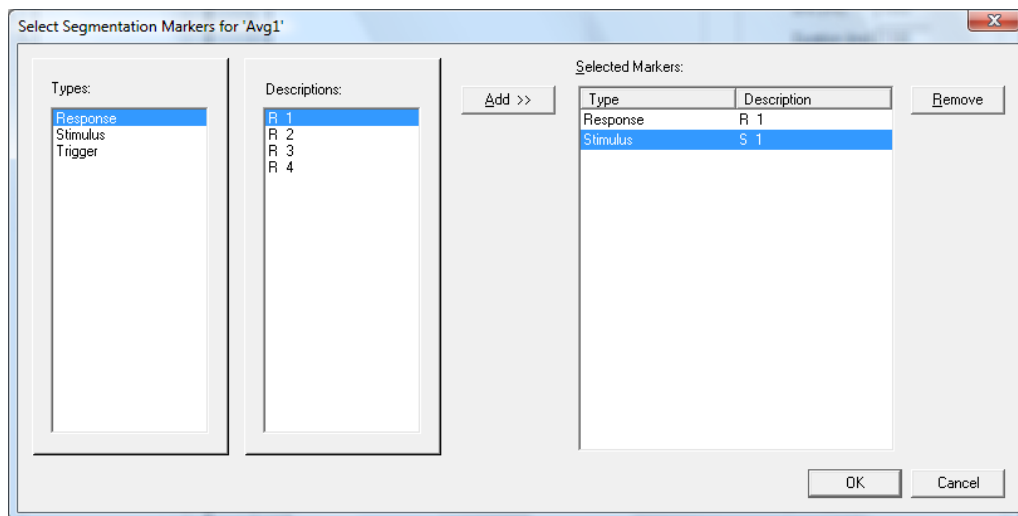


FIGURE 6—21 DIALOG BOX FOR SELECTING MARKERS

Click **Add** to add the markers to the **Selected Markers** list. To remove a marker from this list, select it and click **Remove**. Once you have completed selection of the markers, click **OK**.

The **Interval Relative to Markers** group box allows you to set the relative positions of the segment interval in one of two ways: **Based on Time** or **Based on Data Points**.

“INTERVAL RELATIVE TO MARKERS” GROUP BOX

You specify the **Start** and **End** of the interval or alternatively the duration of the interval instead of the end.

When defining an interval, make sure that it is not too large, as the Recorder will not include overlapping segments in segmentation / averaging.

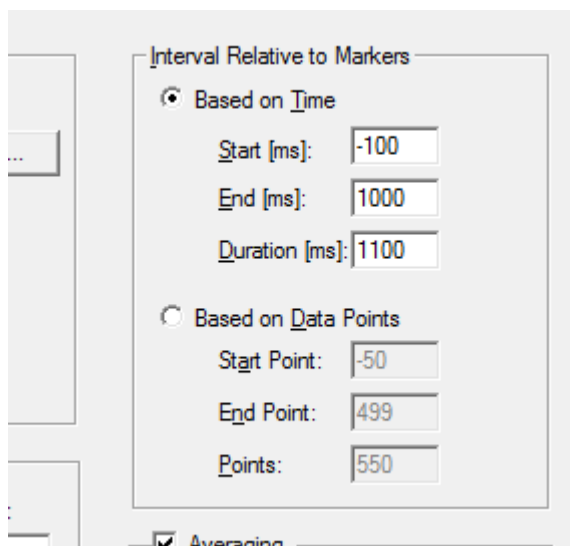


FIGURE 6—22 INTERVAL RELATIVE TO MARKERS GROUP BOX

“ARTIFACT REJECTION”  
GROUP BOX

The **Artifact Rejection** group box allows you to examine the individual segments that you want to include in segmentation/averaging for various artifacts, or to carry out a quality check. All segments that are detected as having artifacts are excluded from segmentation/averaging.

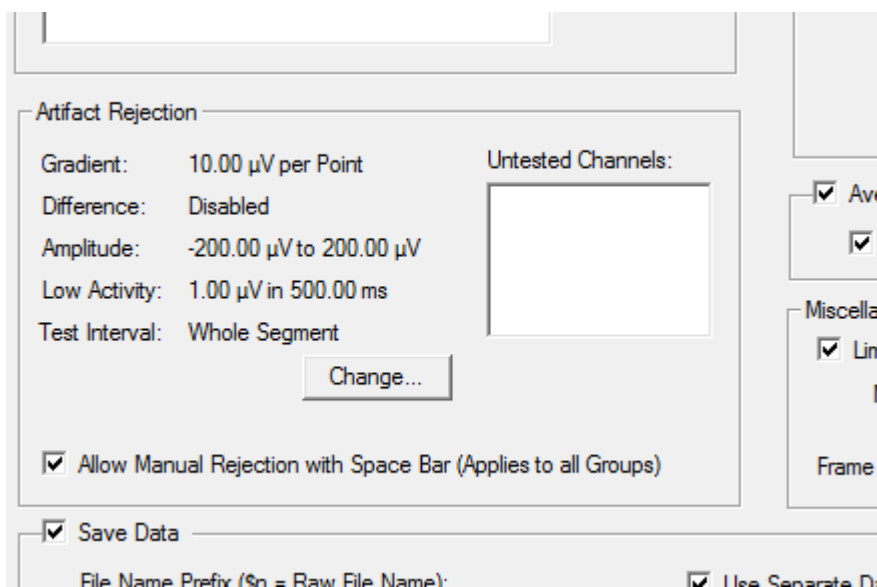


FIGURE 6—23 ARTIFACT REJECTION GROUP BOX

You can also reject artifacts manually. If you check the **Allow Manual Rejection with Space Bar (Applies to all Groups)** box, you can subsequently reject any segment which has just been accepted during segmentation / averaging by pressing the space bar. This is possible until the next segment appears.

If you have defined several segmentation/averaging groups, the rejection refers to the segment of the group with the active window. The segments of the remaining groups which form an intersection with respect to time with the rejected segment are also rejected. However, only the most recently accepted segment in a group is checked.

Four criteria are used to check for artifacts: **Gradient, Difference, Amplitude** and **Low Activity**.

All these criteria are checked at an interval that you have to define. You can also disable individual criteria, or all of them, in which case they are not used for artifact checking.



Furthermore, you can exclude individual channels from artifact checking. This is particularly advisable for ECG channels. Note that with the BrainVision Recorder, the untested channels are selected and not the tested channels as is the case with the ExG analysis software BrainVision Analyzer.

To change the settings for artifact checking, click **Change**. The **Artifact Rejection Criteria** dialog box opens.

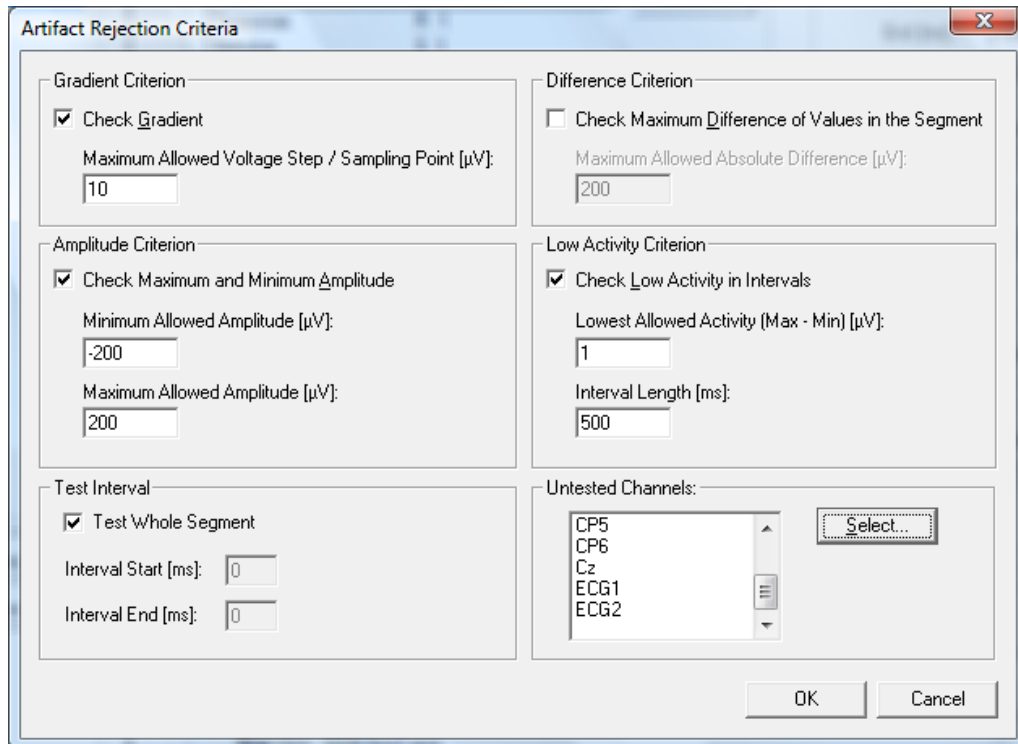


FIGURE 6—24 DIALOG BOX FOR DEFINING (MODIFYING) THE ARTIFACT CHECKING CRITERIA

Check the relevant box to use each of the criteria:

- **Gradient Criterion:** If the gradient criterion is selected, the absolute difference between two neighboring sampling points must not exceed a specified value.

Enter the maximum permitted difference in voltage between two data points in the **Maximal Allowed Voltage Step/Sampling Point [µV]** field.

- **Difference Criterion:** If this criterion is selected, the maximum difference between two values within a segment must not exceed a specified value.

Enter the value of the maximum permitted difference in voltage between the lowest and highest value within the region to be tested in the **Maximum Allowed Absolute Difference [µV]** field.

- **Amplitude Criterion:** If the amplitude criterion is selected, the amplitude must not exceed one specified value and must not fall below another specified value.

Enter the minimum permitted voltage in the **Minimal Allowed Amplitude [µV]** field and the maximum permitted voltage in the **Maximal Allowed Amplitude [µV]** field.

- **Low Activity Criterion:** If this criterion is specified, the system checks whether a minimum amount of activity has occurred within a defined time period. If, for example, you specify a period of 5 ms here, the program checks whether there is no change of voltage of the selected magnitude over a period of 5 ms within the test interval.

Enter the minimum activity in the **Lowest Allowed Activity (Max-Min) [μV]** field.

Enter the length of the interval within which the activity must not fall below the specified amount in the **Interval Length** field.

If you check the **Test Whole Segment** box, the entire segment is checked for artifacts. Alternatively, you can specify the length of the segment to be checked using the **Interval Start [ms]** and **Interval End [ms]** fields.

Under **Untested Channels**, you can use the **Select** button to select the channels that are to be ignored during artifact checking.

#### “AVERAGE” GROUP BOX

The **Average** group box allows you to specify whether the data is to be segmented or averaged. If you opt for averaging, you can also perform a baseline correction (**Baseline Correction** check box).

Baseline correction adjusts the baseline of every segment. Correction is carried out immediately before averaging. The average voltage value of the prestimulus interval is defined as the new zero value. In other words, the average of the points in the prestimulus interval is ascertained, and this is subtracted from all points in the segment. This operation is performed for all channels.

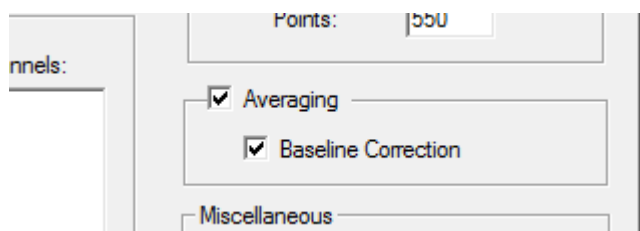


FIGURE 6—25 CHECK BOX FOR AVERAGING AND PERFORMING A BASELINE CORRECTION

#### “MISCELLANEOUS” GROUP BOX

The **Miscellaneous** group box incorporates two functions:

**Limited Number of Segments:** With this option you can limit the number of segments that you want to record during segmentation or include in averaging.

**Frame Color:** Here you can select a frame color for the group in order to identify the associated data window.

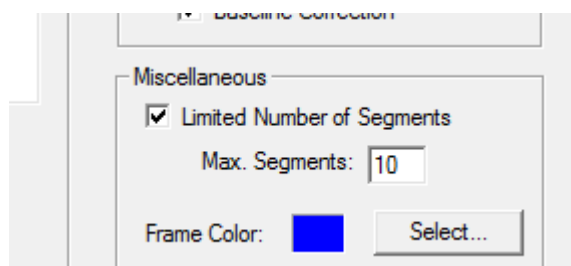


FIGURE 6—26 MISCELLANEOUS GROUP BOX

The **Save Data** group box contains options for saving the group data.

“SAVE DATA” GROUP  
BOX

The screenshot shows a dialog box titled "SAVE DATA" GROUP BOX. At the top, there are two checkboxes: "Allow Manual Rejection with Space Bar (Applies to all Groups)" which is checked, and "Save Data" which is also checked. To the right of the "Save Data" checkbox is a "Frame Color:" label with a blue color swatch and a "Select..." button. Below the "Save Data" checkbox, there are two columns of options. The left column has a "File Name Prefix (\$n = Raw File Name):" label followed by a text box containing "\$n-". Below this is a "Resulting File Name:" label followed by a text box containing "BrainAmp\_0001-Avg1.avg". The right column has a "Use Separate Data Folder" checkbox which is checked, followed by a "Folder Name:" label and a text box containing "c:\Avg1". To the right of the "Folder Name" text box is a "Browse..." button.

FIGURE 6—27 SAVE DATA GROUP BOX

If you check the **Save Data** box, the data is stored when you press the **Start** button in the subsequent data view.

Enter a file name in the **File Name Prefix** field. You can also use the \$n placeholder. Wherever this placeholder occurs, it is replaced by the name of the raw file. The group name and a file extension are added to the name that you enter here. The name that is formed is shown under **Resulting File Name**.

If you do not check the **Use Separate Folder** box, the previously defined raw data folder is used. Otherwise, you can click **Browse...** to select a separate folder for the group under Folder Name.

Click **Finish** when you have completed your settings.

## 6.4.2 Viewing and recording data

## VIEWING DATA

If the Recorder is in standard view mode, click the **Monitor**  button in the toolbar.

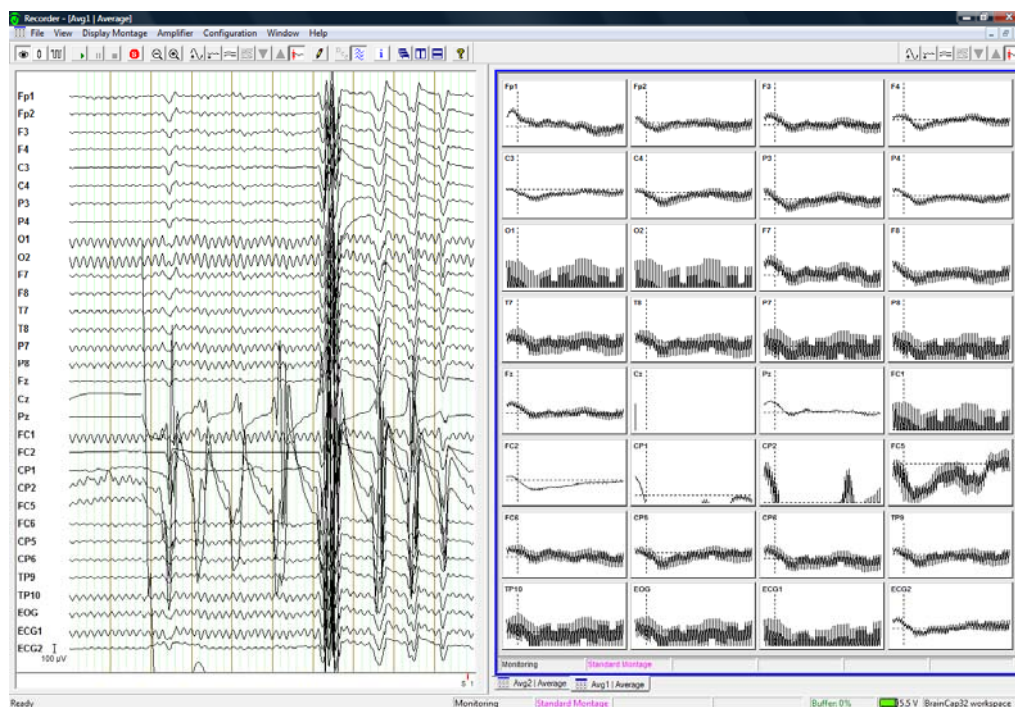


FIGURE 6—28 MONITORING WINDOW AND REPRESENTATION OF AVERAGING GROUPS

The workspace is split into two parts. On the left you see the monitoring window and on the right a separate data window for every segmentation or averaging group. The data in this window is updated whenever a matching marker is found. The curves are shown in red if the segment does not match the artifact criteria. This enables you to check the criteria easily prior to recording.

If you have activated manual artifact rejection (see section 6.4.1) when you set the parameters, you can now use the space bar during recording to subsequently reject segments which have not automatically been identified as having artifacts.

You can change the ratio between the Monitor view and the segmentation windows by dragging the split bar between them to the left or right with the mouse. However, there is a limit both on the left and on the right to prevent an area disappearing completely from the screen.

There are tabs beneath the group windows. These enable you to quickly bring a group window into the foreground.

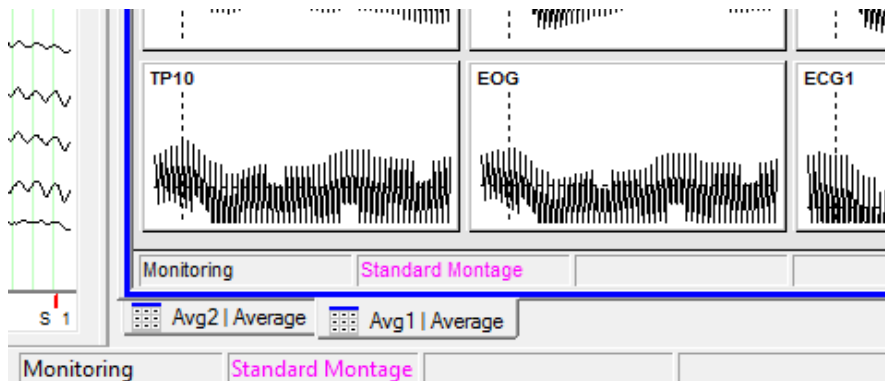


FIGURE 6—29 TABS FOR VIEWING THE INDIVIDUAL GROUPS

You can arrange the group windows in different ways with the buttons below.

-  **Cascade Windows** arranges all open windows on top of each other;
-  **Tile Windows** arranges the windows next to each other;
-  **Tile Windows** arranges the windows one above the other.

Right-clicking in a data window allows you to select a new montage for this window.

To select a new montage for a data window, move the mouse pointer into the relevant window and click the right mouse button.

At the top right of the workspace there is a new toolbar with the following buttons that always relate to the active group window: **Scale Up** , **Scale Down** , **Decrease Channels** , **Increase Channels** , **Next Group** , **Previous Group**  and **Baseline Correction in Display** . Their functions are the same as those of the main toolbar. Note that you have to press **<Ctrl-Shift>** rather than **<Ctrl>** to use the keyboard shortcuts.

You can find detailed information on changing the scaling, the number of channels and channel groups displayed in section 5.2 “The Recorder interface”.





The **Comment** field allows you to enter a comment. This comment is saved in the EEG file. A filename is proposed which you can either accept or change.

Then click **Save**.

[illegible]

FIGURE 6–30 DIALOG BOX FOR SAVING DATA

- whether the raw data and the various groups are to be saved (**Save** button),
- what folder the data is to be saved in (**Folder** column, **Browse** button),
- the name of the file (**File name** column).

The **Base File Name** field is used to enter a base name for the raw file. The \$n placeholders described in section 6.4.1, “Save Data” group box are changed accordingly in the filename fields of the segmentation or averaging groups.

When you click **Save**, the Recorder switches to Save mode.

The status fields in the individual groups now show the number of segments (**Total Segs.**) and the number of accepted segments (**Accepted Segs.**) in addition to the group status and the current montage. In addition, the EEG file name is shown and the remaining storage space in hours, minutes and seconds is shown under **Free Space**. Note that this refers to the capacity that would be available if only the relevant group were stored.

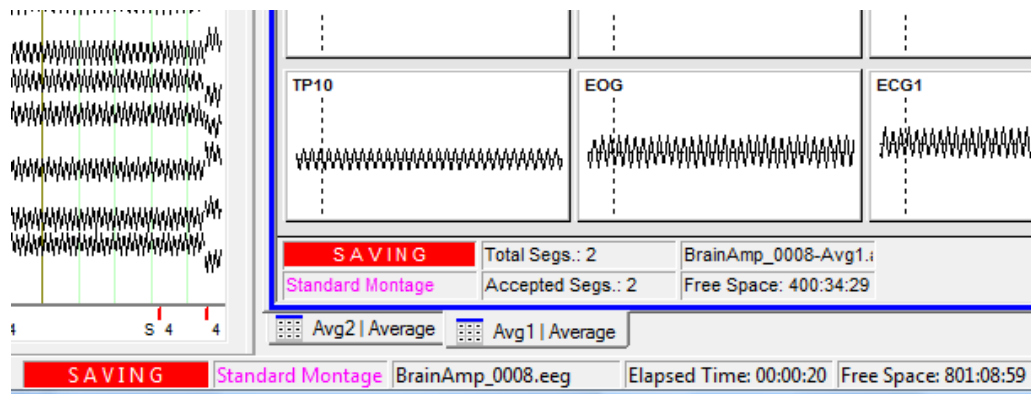


FIGURE 6—31 SAVE MODE



## 7 Program configuration

### 7.1 Configuring the user privileges

Whether or not you have full or restricted access to the functions of the BrainVision Recorder depends on whether you have Administrator privileges or not. All menu commands are available to you if you have Administrator privileges. The following functions are only available to users with Administrator privileges:

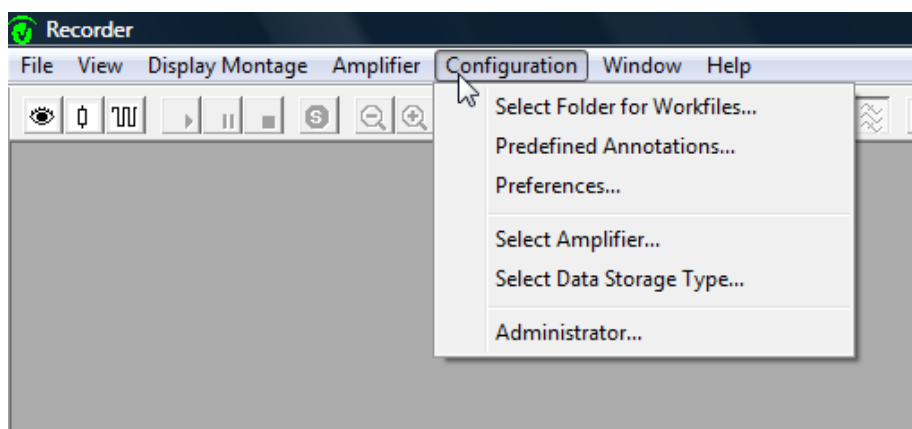


FIGURE 7—1 CONFIGURATION MENU IN ADMINISTRATOR MODE

The command **Configuration > Select Amplifier...** is used to select the amplifier to be controlled.

**Configuration > Select Data Storage Type...** allows you to switch the EEG data output format. Only one format is available in the current version of the Recorder.

**Configuration > Administrator...** opens the **Administrator** dialog box. Here you can further restrict access rights for normal users.

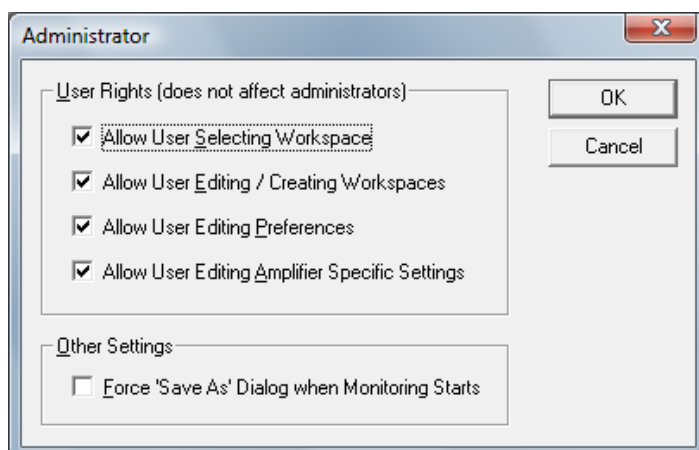


FIGURE 7—2 ADMINISTRATOR DIALOG BOX

You can make the following settings:

- **Allow User Selecting Workspace** specifies whether normal users are permitted to select a workspace.
- **Allow User Editing/Creating Workspaces** specifies whether normal users are permitted to edit existing workspaces and create new ones.
- **Allow User Editing Preferences** specifies whether normal users are permitted to modify the preferences. (For further information on preferences, see section 7.2).
- By checking or unchecking the **Allow User Editing Amplifier Specific Settings** box, you can enable or disable all the items in the Amplifier menu.



Note that the **Amplifier** menu does not appear in the menu bar if you have selected the Simulated Amplifier under **Configuration > Select Amplifier**. Also note that the individual items in the **Amplifier** menu depend on the amplifier selected. You will find a detailed description of the items in the menu in chapter 8 “Amplifier-specific properties”.

- If you check the **Force 'Save As' Dialog when Monitoring Starts** box, the **Start** button is implicitly activated every time the EEG view is called, thus causing the Save dialog box to open.

## 7.2 Configuring the user settings

If you have Administrator privileges or the Administrator has not restricted the privileges of normal users (see also section 7.1), you can set various preferences.

To do this, stop monitoring and choose **Configuration > Preferences...** from the menu bar. The dialog box which opens contains the four tabs **Scaling**, **DC Correction**, **Remote Data Access** and **Vision Video**.

The **Scaling** tab contains the following functions:

“SCALING” TAB

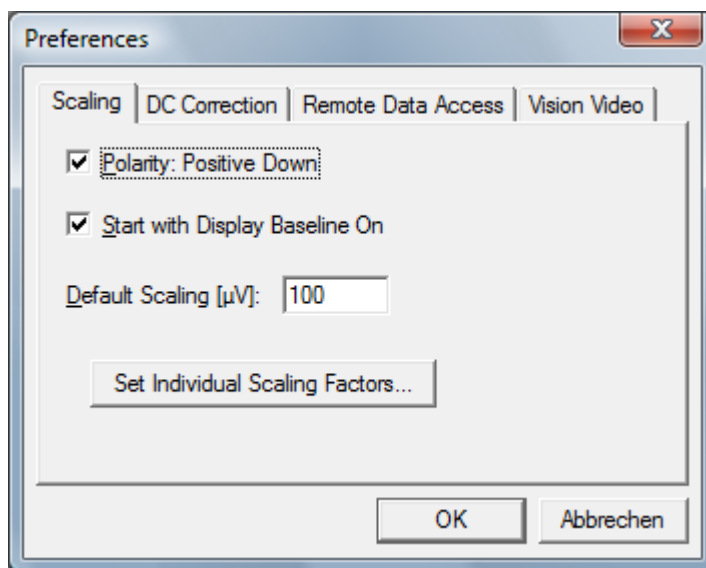


FIGURE 7—3 SETTING THE SCALING PREFERENCES

The **Polarity: Positive Down** function defines the polarity of the displayed signal. If this option is enabled, positive signals are shown facing down.

If you check the **Start with Display Baseline On** box, baseline correction in the EEG display is enabled by default.

The **Default Scaling [µV]** field contains the scaling value to be used when monitoring starts.

The **Set Individual Scaling Factors** function allows you to specify the channels you want to display on a reduced scale. This is, for example, desirable for ECG channels as they would otherwise extend far into the signals of EEG channels. In the table, enter the channel names and the associated scaling factors by which you want to reduce the scale of the signals. This reduction applies to the display only, and not to the data.

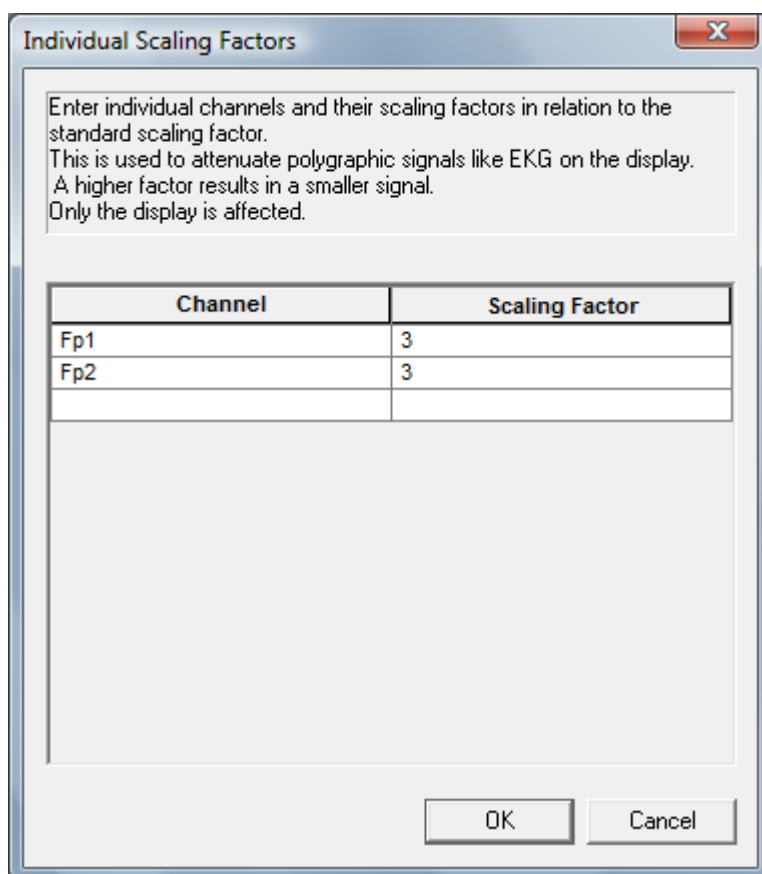


FIGURE 7—4 ENTERING SCALING FACTORS

**“DC CORRECTION” TAB**

Check the **Automatic DC Correction** box to activate automatic DC correction. The **Threshold [%]** field is used to specify the threshold (as a percentage) at which DC correction is performed. For further information on DC correction, refer to section 6.2.3.

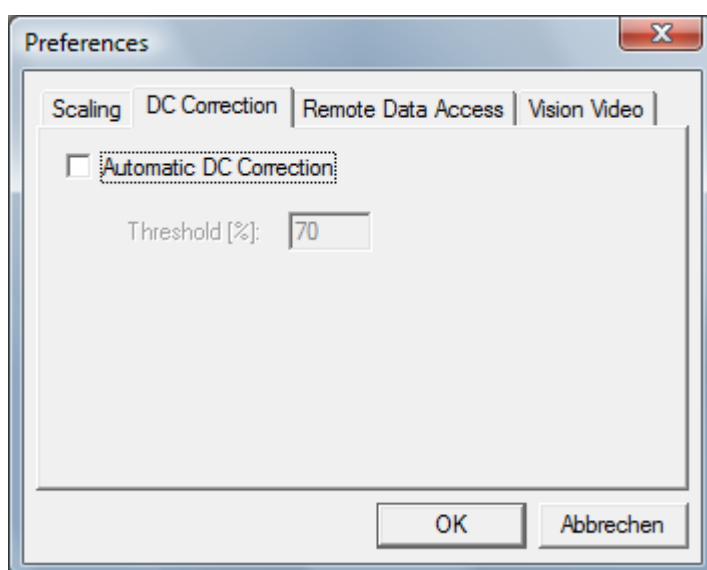


FIGURE 7—5 ENABLING AUTOMATIC DC CORRECTION

Check the **Enable Remote Data Access** box to enable the RDA server. For further information, refer to chapter 10 “Remote Data Access”.

“REMOTE DATA  
ACCESS” TAB

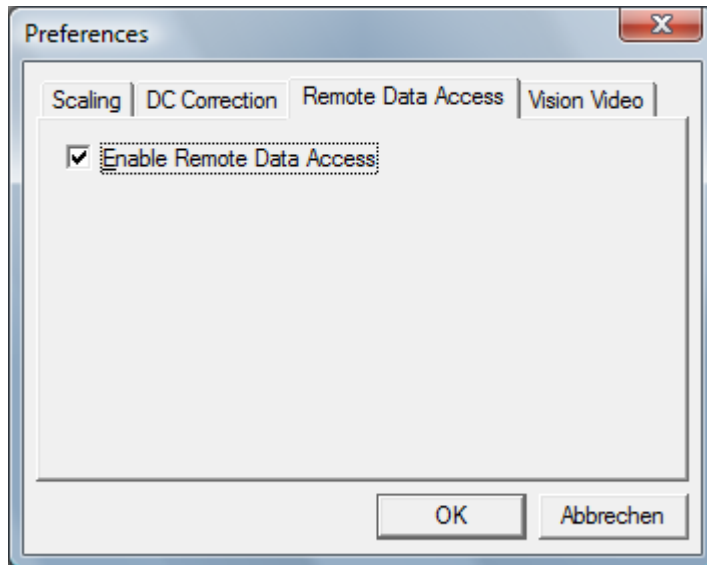


FIGURE 7—6 ACTIVATING THE RDA SERVER

If you have purchased a video license and have installed the video recorder correctly, the additional tab **Vision Video** is available. For information on the functions available and how to use the Vision Video option, refer to chapter 11 “BrainVision Video Recorder”.

“VISION VIDEO” TAB

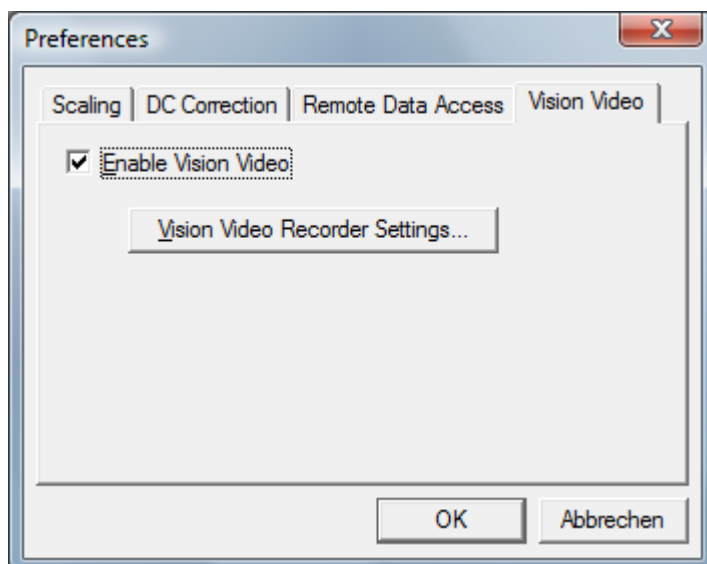


FIGURE 7—7 ACTIVATING THE VISION VIDEO FUNCTION



## 8 Amplifier-specific properties

This chapter contains detailed information on the amplifier-specific properties of the following models of EEG amplifier: BrainAmp, QuickAmp and V-Amp/FirstAmp and of the options Simulated Amplifier and the NI 6071e A/D converter board from National Instruments.

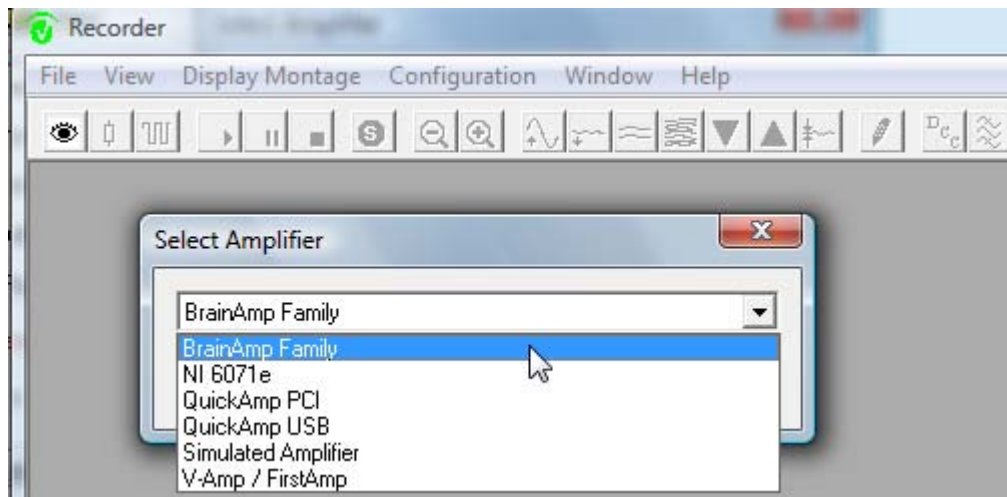


FIGURE 8—1 SELECTING THE AMPLIFIER

### 8.1 BrainAmp family

Note that PCI cards are currently **NOT** supported under Windows® Vista.

RESTRICTIONS TO USE

You will find detailed information on configuring the amplifier-specific parameters in the **Edit Workspace – Amplifier Settings** dialog box in section 5.3.2.



If you are using an EEG amplifier from the BrainAmp range, the Amplifier menu contains the following items: **Test Signal Values...**, **Digital Port Settings...**, **Connected Amplifiers...**, **SyncBox Settings...** and **Driver Version...**

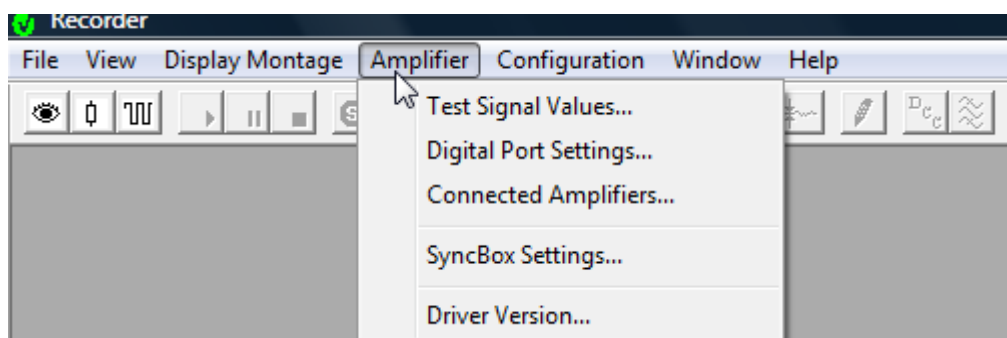


FIGURE 8—2 AMPLIFIER MENU FOR AMPLIFIERS FROM THE BRAINAMP RANGE

### 8.1.1 Impedance measurement

If you are using a BrainAmp amplifier, you should observe the following points in addition to the information given in section 6.1 “Impedance measurement”:

With the BrainAmp, there are three groups of electrodes that are measured separately: data electrodes, one reference electrode and one ground electrode. These groups are not completely independent of each other so you should observe the following sequence:

- First apply the electrodes.
- Then measure the data electrodes. You can choose from five measuring ranges: 100, 50, 20, 10 and 5 kOhm. Start with the larger range. If all electrodes are in a high-impedance state, check that the reference and ground electrodes are connected firmly.
- If you want to define other measuring ranges, you can do so by clicking **Settings** in the **Zoom** group box (see Figure 8–3).
- If the data electrodes have resistance values that are roughly correct, measure the reference electrode. Note that there is only a maximum measuring range from 0 to 10 kOhm.
- Finally measure the ground electrode. For the ground electrode also, there is only a maximum measuring range from 0 to 10 kOhm.

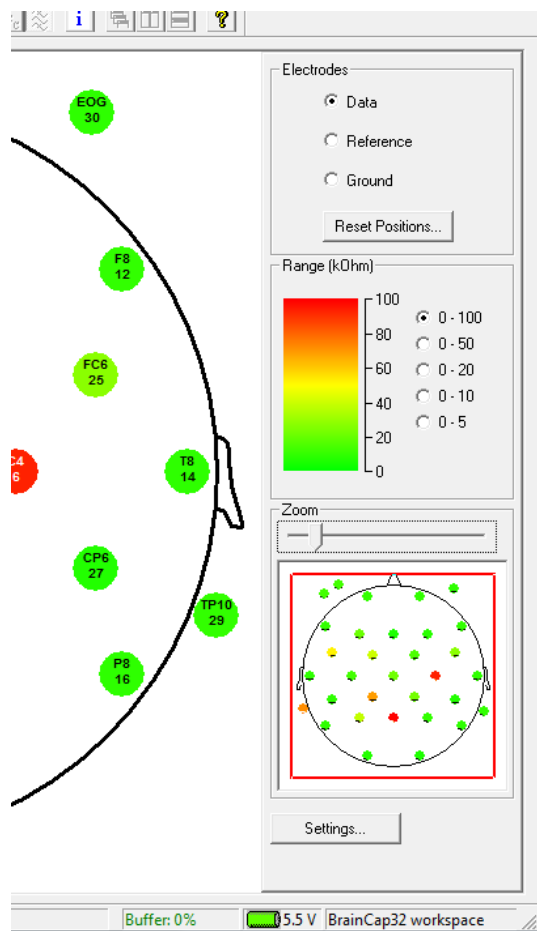


FIGURE 8—3 SETTINGS FOR IMPEDANCE MEASUREMENT

### 8.1.2 Test signal

To display or record a test signal, attach the supplied test signal generator to the EEG amplifier via the electrode input socket.

When you click the **Test Signal**  button, a signal with an amplitude of 50  $\mu\text{V}_{\text{pp}}$  (square) or 100  $\mu\text{V}_{\text{pp}}$  (sine) is generated and displayed.

Choose **Amplifier > Test Signal Values...** from the menu to select the wave form (square or sine).

The **Frequency [Hz]** field allows you to specify the frequency of the signal in a range 1 through 50 Hz.

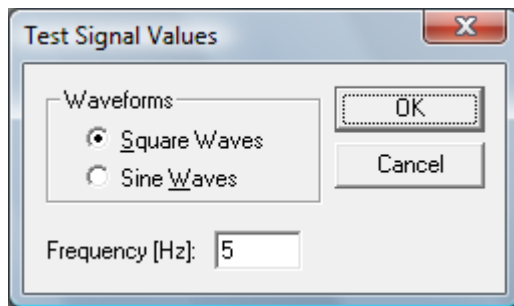


FIGURE 8—4 SELECTING THE TEST SIGNAL

### 8.1.3 Configuring the digital port (marker port)

The amplifier's PC adapter or USB adapter incorporates a 26-pole HD-sub socket for recording time-synchronous events such as stimuli or patient responses. The socket contains 16 1-bit digital inputs that can be programmed separately from each other. The exact pinout of the socket is given in the Appendix A of the Operating Instructions for the BrainAmp or BrainAmp MR. The designations D00 through D15 relate to the bit number, with the first bit being designated with 0.

You make the settings for the digital port by choosing **Amplifier > Digital Port Settings....**

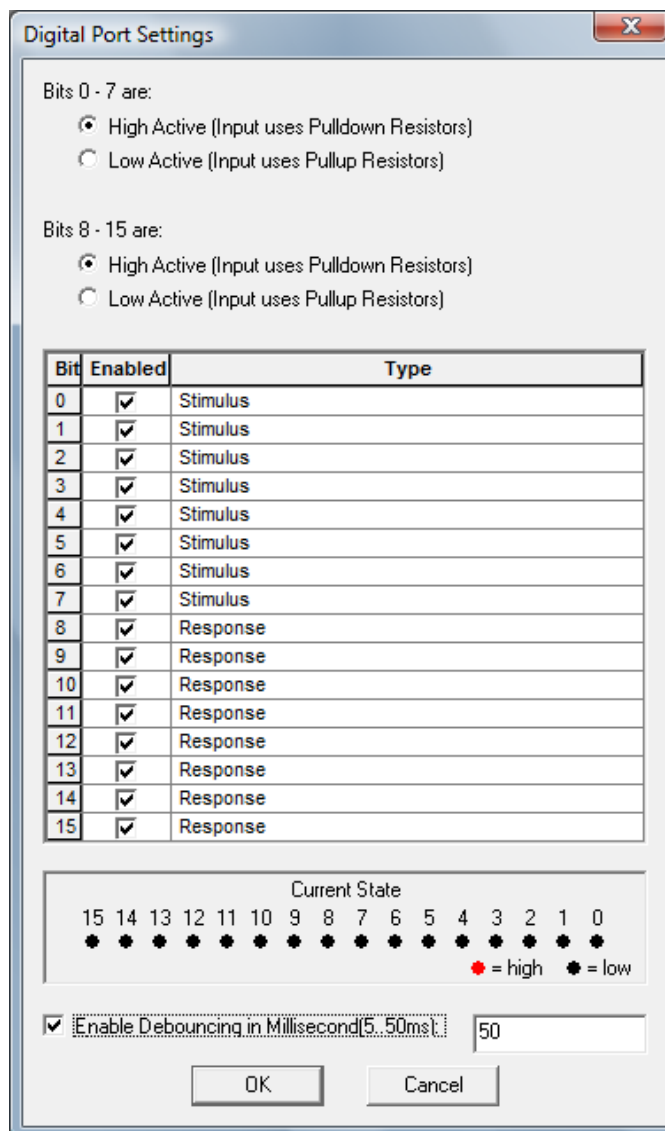


FIGURE 8—5 SETTING THE DIGITAL PORT (BRAINAMP)

For each group of 8 bits (bit 0 – 7 and bit 8 – 15) you can define whether the signals are interpreted as high-active (5 V = active) or low active (0 V = active). In addition, pulldown (high-active) or pullup (low-active) resistors with a value of 4.9 kOhm are switched to ground or 5 volts at each input.

In the **Enabled** column of the table, you can specify whether the associated bit is to be evaluated or not. In the **Type** column, you can specify what time marker type each bit represents. It is also possible to assign the same type to several different bits.

In principle, you can freely select the name of the type. You should, however, note that BrainVision Recorder and BrainVision Analyzer use color coding for certain types. For this reason, it is advisable to choose “Stimulus” and “Response” for stimulus and response inputs respectively.



The marker type “DC Correction” is also available if you are carrying out a DC measurement. You can define this at any bit position (0-15) you choose.

ADDITIONAL MARKER  
TYPE FOR DC  
MEASUREMENTS

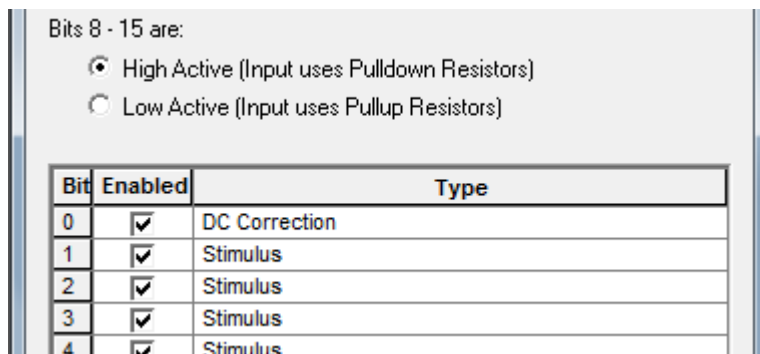


FIGURE 8—6 ADDITIONAL MARKER TYPE "DC CORRECTION" DURING DC MEASUREMENTS

DC correction is automatically performed when this marker is received. If several markers of the type “DC Correction” are set simultaneously, correction is only performed once. This applies to both USB and PCI ports.

The description of the markers is encoded automatically. The following procedure is used: The first occurrence of the type in the table is weighted with value 1, the second occurrence with value 2, the third with value 4 etc. For every data point, all set bits of a type are added together according to this pattern. The resultant number is combined with the initial letter of the type, resulting in the description.

Bit 8 through bit 15 are of the type “Response”. If bits 11 and 13 are set, this results in a marker of the type “Response” with the description “R 40”. Bit 11 has a value of 8 and bit 13 a value of 32. The total is 40.

EXAMPLE

The consequence of this logic is that only markers of different types can be detected at any one time. If you want to record different responses simultaneously, you can do so by decoding the number values subsequently in the analysis, i.e. assigning a separate marker to every bit. Alternately, you can assign a separate type to every bit in the table.

You can view the current state of the digital port for test purposes in the **Current State** field.

Another option available in the **Digital Port Settings** dialog box is debouncing. If you check the **Enable Debouncing in Millisecond (5..50 ms)** box, repetition of a marker of the same type and same description is ignored for a period of 5 through 50 ms.

Note that trigger signals must be present at least for the extent of a sampling point. This means, for instance, that at a sampling rate of 1000 Hz, the minimum length of the trigger signal is 1 ms. At 500 Hz, the minimum length is 2 ms etc.



## 8.1.4 ExG AUX Box

The ExG AUX Box allows you to connect single electrodes in order to capture bipolar signals and/or polygraph sensors on the BrainAmp ExG or the BrainAmp ExG MR.

If you wish to use sensors to measure temperature, skin conductivity etc. you can make the appropriate settings in the **Amplifier** menu of the Vision Recorder. To do this, choose **File > Edit Workspace**. To use the ExG AUX Box, check the **Use ExG AUX** box on the **Edit Workspace – Amplifier Settings** page of the dialog box.

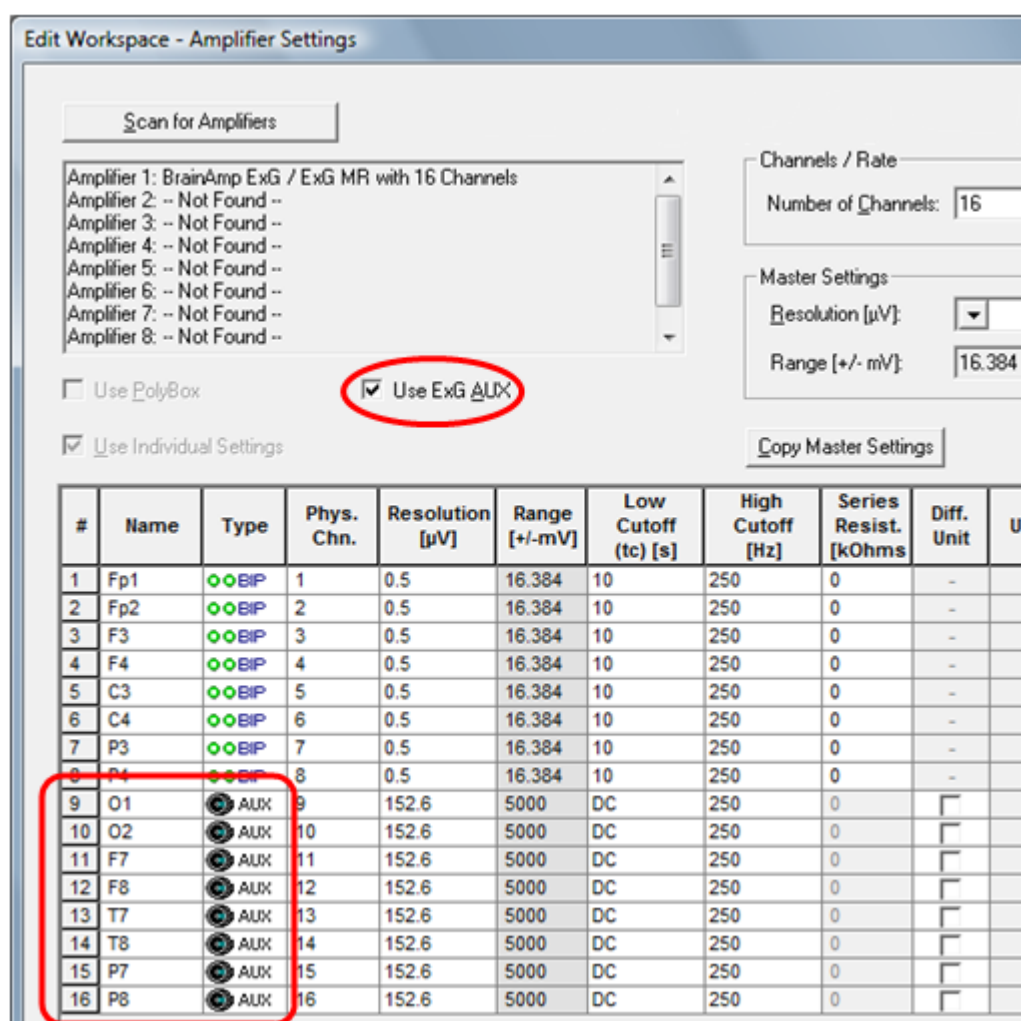


FIGURE 8—7 EXTRACT FROM THE “EDIT WORKSPACE – AMPLIFIER SETTINGS” PAGE, USING THE EXG AUX BOX AND DISPLAYING THE AUX CHANNELS

If installation has been carried out correctly, the AUX channels are always the last eight physical channels. If you are using a BrainAmp ExG/ExG MR amplifier, these are the physical channels 9 through 16 (see highlighted section in Figure 8–7). If you are using a BrainAmp and a BrainAmp ExG, these are the physical channels 41 through 48. If you are using two BrainAmp amplifiers and one BrainAmp ExG, these are the physical channels 73 through 80, etc. If you are using only two BrainAmp ExG amplifiers, these are the physical channels 9 through 16 and 25 through 32 etc.

When you have selected the channels in the **Phys. Chn.** column, additional data entry columns become available in the table:

- **Diff. Unit:** If you check this box, you can use a different unit, such as “C” for Celsius.
- **Unit:** Specify the unit here.
- **Gradient:** These columns allow you to specify the gradient in mV/unit; with a unit “C”, for example, mV/C. In this example, you are describing the voltage difference in mV for a temperature change of one degree Celsius. This value can also be negative.
- **Offset:** The offset defines the zero point. In our temperature example, this is the voltage in mV that the sensor returns at a temperature of 0 degrees Celsius.

| #  | Name | Type | Phys. Chn. | Diff. Unit                          | Unit | Gradient |      | Offset |             |
|----|------|------|------------|-------------------------------------|------|----------|------|--------|-------------|
| 10 |      | EEG  | 10         | -                                   | -    | -        | -    | -      | -           |
| 11 | T7   | EEG  | 11         | -                                   | -    | -        | -    | -      | -           |
| 12 | T8   | EEG  | 12         | -                                   | -    | -        | -    | -      | -           |
| 13 | P7   | EEG  | 13         | -                                   | -    | -        | -    | -      | -           |
| 14 | P8   | EEG  | 14         | -                                   | -    | -        | -    | -      | -           |
| 15 | Fz   | EEG  | 31         | -                                   | -    | -        | -    | -      | -           |
| 16 | Cz   | EEG  | 32         | -                                   | -    | -        | -    | -      | -           |
| 17 | Pz   | AUX  | 33         | <input checked="" type="checkbox"/> | C    | 200      | mV/C | 80     | 80 mV = 0 C |
| 18 | FC1  | AUX  | 34         | <input checked="" type="checkbox"/> | C    | 200      | mV/C | 80     | 80 mV = 0 C |
| 19 | FC2  | AUX  | 35         | <input checked="" type="checkbox"/> | C    | 200      | mV/C | 80     | 80 mV = 0 C |
| 20 | CP1  | AUX  | 36         | <input type="checkbox"/>            | -    | -        | -    | -      | -           |

FIGURE 8—8 SECTION OF THE TABLE, ADDITIONAL COLUMNS

If you are using the GSR-MR module with the ExG AUX Box, you can set up a GSR-MR channel in the workspace.

SETTING UP A GSR-MR CHANNEL

The input signals for the GSR-MR module must undergo correction. Proceed as follows to load the corrected values:

- In the table, check the box in the **Diff. Unit** column.
- Move the mouse pointer to the name of the corresponding channel and click once.
- The drop-down arrow appears in this line. Select the option **GSR\_MR\_100\_xx** from the drop-down menu. You have the option of changing the end of the channel name (“\_xx”).

Do not, however, change any of the other characters in the name of the GSR-MR channel!



Now the program automatically loads the corrected values.

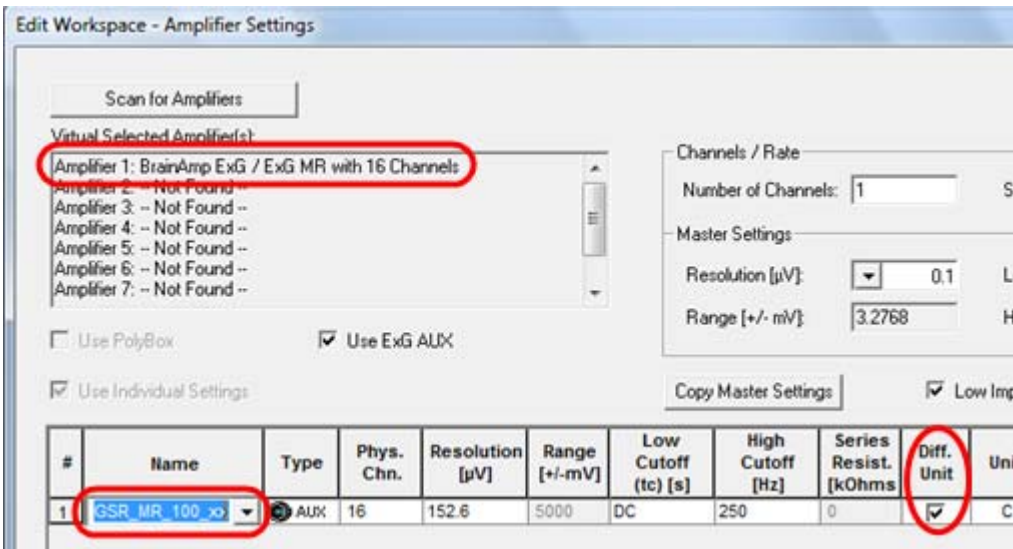


FIGURE 8—9 SETTING UP A GSR CHANNEL



You can find detailed information on using the GSR-MR sensor in the Operating Instructions for this module (“BrainVision\_GSR-MR-Module\_Operating\_Instructions-001.pdf”).

### 8.1.5 SyncBox

The SyncBox is used to synchronize the clock cycle of MR data acquisition by the BrainAmp with the clock cycle used to control the MR system's gradient switching system. The aim is to achieve phase synchronicity between the two clock systems. This results in a temporary stability of EEG acquisition in terms of the transmission of the gradients during MR acquisition.

Choose **Amplifier > SyncBox Settings...** to access the SyncBox settings.

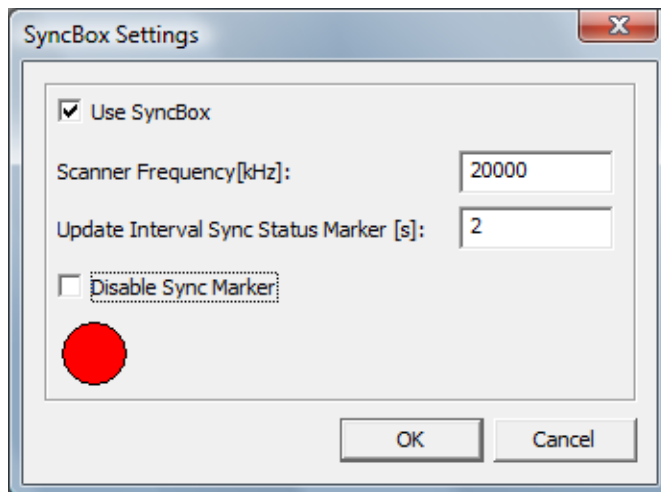


FIGURE 8—10 SETTINGS FOR THE SYNCBOX

If you check the **Use SyncBox** box, the associated icon appears in the status bar in both monitoring mode and save mode. The green icon indicates that synchronization is on and the red icon indicates that synchronization is off.

In addition, every change to the synchronization status is recorded as a trigger and saved accordingly in save mode (**Sync On** and **Sync Off**). When monitoring mode or save mode is started, the current status of the SyncBox is recorded as a trigger.

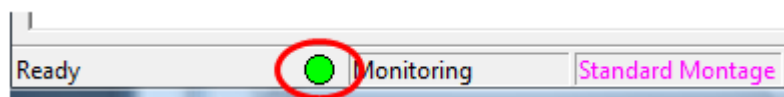


FIGURE 8—11 ICON INDICATES THAT THE SYNCBOX IS BEING USED

The **Scanner Frequency [kHz]** is the frequency of the signal on the gradient board of the MR system that the scanner interface of the SyncBox is connected to. Note that this value is specified in kilohertz (kHz). This means that the value 20000 in Figure 8–10 represents a 20 MHz input signal at the SyncBox.

Check or uncheck the **Disable Sync Marker** box to specify whether or not synchronization markers are to be written during synchronization. If you use this function, markers are written to the data stream every few seconds indicating the synchronization status, i.e. “in sync” or “out of sync”. Only check this box if you do not want this to happen.

The **Update Interval Sync Status Marker [s]** allows you to specify the frequency with which these markers are written.

### 8.1.6 Displaying the amplifiers connected

Choose **Amplifier > Connected Amplifiers** to determine which BrainAmp amplifiers of which type are currently connected to your PC and are ready for operation.

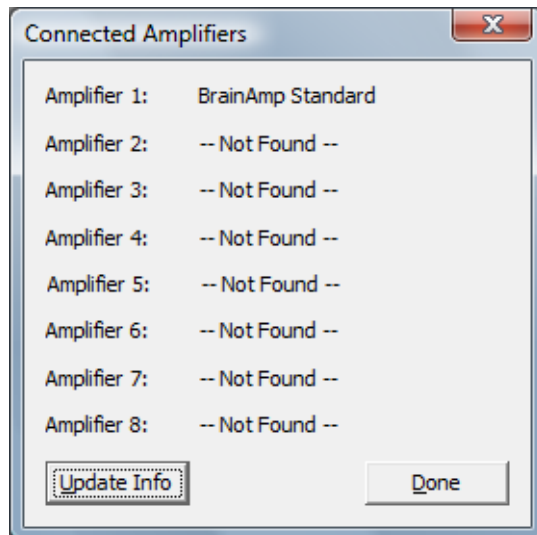


FIGURE 8—12 LIST OF CONNECTED AMPLIFIERS

## 8.2 QuickAmp PCI and QuickAmp USB

Note that the QuickAmp PCI and QuickAmp USB are **NOT** compatible with Windows® Vista.

RESTRICTIONS TO USE

As of Version 1.10 of the Recorder, two types of QuickAmp are distinguished: QuickAmp PCI and QuickAmp USB.



The QuickAmp PCI is used in combination with a 22-bit QuickAmp amplifier and a PCI card. The driver version for the QuickAmp PCI is V.5.o.3.2 and can be found in the file **\RecorderDrivers\QuickAmp PCI.zip** on the BrainVision CD.

The QuickAmp USB is used in combination with a 24-bit/22-bit QuickAmp amplifier (40/72/136 channel system) and USB. The correct driver version is V.6.o.o.76 and can be found in the **\RecorderDrivers\QuickAmp USB** folder on the BrainVision CD.

Note that only the QuickAmp USB supports non-Administrator mode (i.e. user mode).



If you are using a QuickAmp amplifier, the Amplifier menu in the menu bar contains the items **Test Signal Values...** and **Digital Port Settings...**

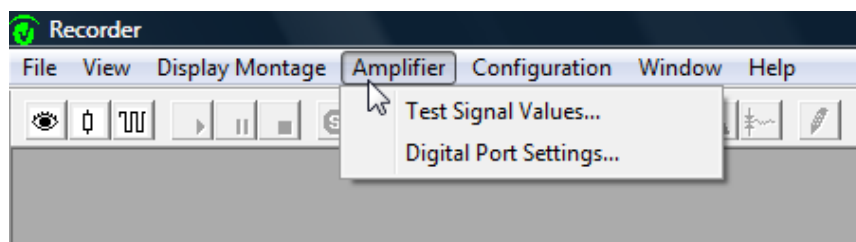


FIGURE 8—13 MENÜPUNKT AMPLIFIER FÜR QUICKAMP-VERSTÄRKER

### 8.2.1 Adapting sensors for the auxiliary (AUX) inputs (PCI and USB)

If you wish to use external sensors to measure temperature, skin conductivity etc. you can make the appropriate changes in the Amplifier menu of the QuickAmp PCI and QuickAmp USB.

To set the parameters for the sensors, choose **File > Edit Workspace** from the menu. Go to the page **Edit Workspace – Amplifier Settings**.

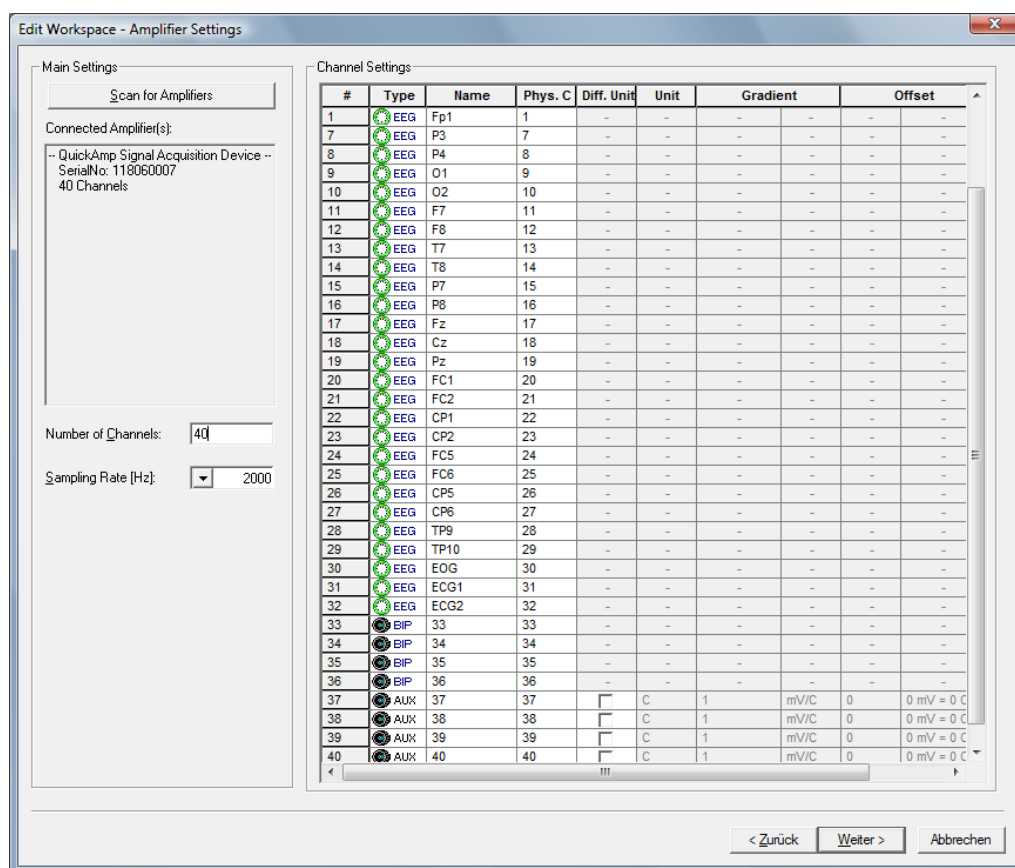


FIGURE 8—14 EDITING A WORKSPACE, PAGE 2 “AMPLIFIER SETTINGS” FOR THE QUICKAMP PCI/USB

The AUX channels are always the last four channels of an amplifier. If you are using a QuickAmp40, you can thus use physical channels 37 through 40. With a QuickAmp72, use channels 69 through 72 and with a QuickAmp128, channels 125 through 128.

|    |     |      |    |                          |   |   |      |   |
|----|-----|------|----|--------------------------|---|---|------|---|
| 30 | EEG | ECG  | 30 | -                        | - | - | -    | - |
| 31 | EEG | ECG1 | 31 | -                        | - | - | -    | - |
| 32 | EEG | ECG2 | 32 | -                        | - | - | -    | - |
| 33 | BIP | 33   | 33 | -                        | - | - | -    | - |
| 34 | BIP | 34   | 34 | -                        | - | - | -    | - |
| 35 | BIP | 35   | 35 | -                        | - | - | -    | - |
| 36 | BIP | 36   | 36 | -                        | - | - | -    | - |
| 37 | AUX | 37   | 37 | <input type="checkbox"/> | C | 1 | mV/C | 0 |
| 38 | AUX | 38   | 38 | <input type="checkbox"/> | C | 1 | mV/C | 0 |
| 39 | AUX | 39   | 39 | <input type="checkbox"/> | C | 1 | mV/C | 0 |
| 40 | AUX | 40   | 40 | <input type="checkbox"/> | C | 1 | mV/C | 0 |

FIGURE 8—15 QUICKAMP, AUX CHANNELS

When you have selected the channels in the **Phys. Chn.** column, additional data entry columns become available in the same way as with the BrainAmp:

- **Diff. Unit:** If you check this box, you can use a different unit, such as “C” for Celsius.
- **Unit:** Specify the unit here.
- **Gradient:** These columns you to specify the gradient in mV/unit; with a unit “C”, for example, mV/C. In this example, you are describing the voltage difference in mV for a temperature change of one degree Celsius. This value can also be negative.
- **Offset:** The offset defines the zero point. In our temperature example, this is the voltage in mV that the sensor returns at a temperature of 0 degrees Celsius.

### 8.2.2 Test signal

To display or record a test signal, attach the supplied test signal generator to the EEG amplifier via the electrode input socket. In the toolbar, click the **Test Signal**  button. A square wave signal is generated and displayed.

Note that the test signal is not calibrated. It is only an approximate value.

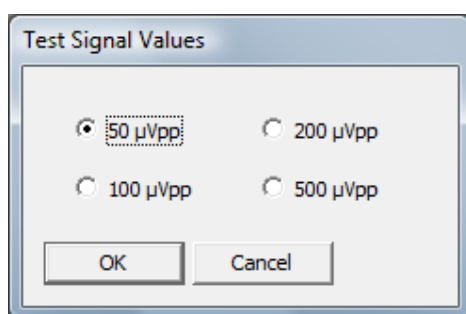


FIGURE 8—16 SETTING THE TEST SIGNAL PARAMETERS

### 8.2.3 Configuring the digital port (marker port)

Use the digital ports DIO0 through DIO7 for recording time-synchronous events such as stimuli or patient responses. The designations DIO0 through DIO7 relate to the bit number, with the first bit being designated with 0.

You make the settings for the digital port by choosing **Amplifier > Digital Port Settings....**



Note that the contents of the dialog box differ in respect of the debouncing parameters with the QuickAmp PCI and QuickAmp USB.

**Digital Port Settings**

Bits are:

☒ High Active  
☐ Low Active

| Bit | Enabled                             | Type     |
|-----|-------------------------------------|----------|
| 0   | <input checked="" type="checkbox"/> | Stimulus |
| 1   | <input checked="" type="checkbox"/> | Stimulus |
| 2   | <input checked="" type="checkbox"/> | Stimulus |
| 3   | <input checked="" type="checkbox"/> | Stimulus |
| 4   | <input checked="" type="checkbox"/> | Response |
| 5   | <input checked="" type="checkbox"/> | Response |
| 6   | <input checked="" type="checkbox"/> | Response |
| 7   | <input checked="" type="checkbox"/> | Response |

Current State

7 6 5 4 3 2 1 0  
 ● ● ● ● ● ● ● ●

● = high   ● = low

☐ Enable Debouncing (suppresses repetition for 50 ms)

OK Cancel

FIGURE 8—17 SETTING THE DIGITAL PORT FOR THE QUICKAMP PCI

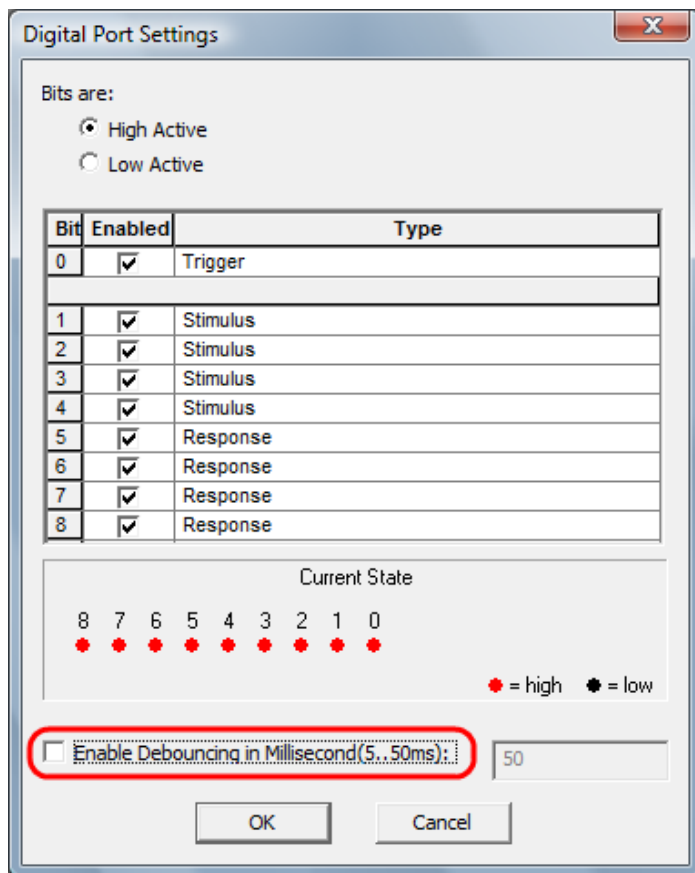


FIGURE 8—18 SETTING THE DIGITAL PORT FOR THE QUICKAMP USB

You can choose whether the signals are interpreted as high-active (5 V = active) or low active (0 V = active).

In the **Enabled** column of the table, you can specify whether the associated bit is to be evaluated or not. In the **Type** column, you can specify what time marker type each bit represents. It is also possible to assign the same type to several different bits.

In principle, you can freely select the name of the type. You should, however, note that BrainVision Recorder and BrainVision Analyzer use color coding for certain types. For this reason, it is advisable to choose “Stimulus” and “Response” for stimulus and response inputs respectively.



The description of the markers is encoded automatically. The following procedure is used: The first occurrence of the type in the table is weighted with value 1, the second occurrence with value 2, the third with value 4 etc. For every data point, all set bits of a type are added together according to this pattern. The resultant number is combined with the initial letter of the type, resulting in the description.

Bit 4 through bit 7 are of the type “Response”. If bits 5 and 7 are set, this results in a marker of the type “Response” with the description “R 10”. Bit 5 has a value of 2 and bit 7 a value of 8. The total is 10.

EXAMPLE

The consequence of this logic is that only markers of different types can be detected at any one time. If you want to record different responses simultaneously, you can do so by decoding the number values subsequently in the analysis, i.e. assigning a separate marker to every bit. Alternately, you can assign a separate type to every bit in the table.

You can view the current state of the digital port for test purposes in the **Current State** field.

Another option available in the **Digital Port Settings** dialog box is debouncing.

- QuickAmp PCI: If you check the **Enable Debouncing (suppresses repetition for 50 ms)** box, repetition of a marker of the same type and same description is ignored for a period of 50 ms.
- QuickAmp USB: If you check the **Enable Debouncing in Millisecond (5..50 ms)** box, repetition of a marker of the same type and same description is ignored for a period of 5 through 50 ms.



Note that trigger signals must be present at least for the extent of a sampling point. This means, for instance, that at a sampling rate of 1000 Hz, the minimum length of the trigger signal is 1 ms. At 500 Hz, the minimum length is 2 ms etc.

## 8.3 V-Amp and FirstAmp

If you are using a V-Amp/FirstAmp amplifier, the Amplifier menu in the menu bar contains the item **Digital Port Settings....**

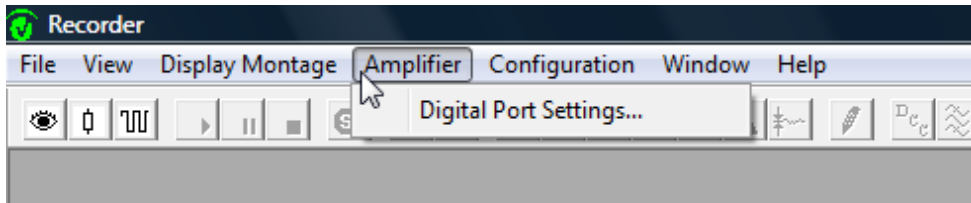


FIGURE 8—19 AMPLIFIER MENU FOR V-AMP/FIRSTAMP AMPLIFIERS

If you have installed a BrainVision Recorder Professional Edition, please note the following:



The driver and an additional Windows service must be installed in addition to the Recorder software. To do this, insert the installation CD in your CD ROM drive and use the **Browse the CD** function to go to the folder **FirstAmp, V-Amp**. Run the file with the name **FirstAmpACC-xxx.exe**. Make sure that no amplifier is connected during installation.

As of Version 1.10 of the Recorder, the V-Amp and FirstAmp are also supported in non-Administrator mode (i.e. user mode).



### 8.3.1 Adapting sensors for the auxiliary (AUX) inputs

If you wish to use external sensors to measure temperature, skin conductivity etc. connect the sensors to the AUX1 or AUX2 ports of the amplifier and make the appropriate changes in the Amplifier menu of the V-Amp/FirstAmp.

To set the parameters for the sensors, choose **File > Edit Workspace** from the menu. Go to the page **Edit Workspace – Amplifier Settings**.

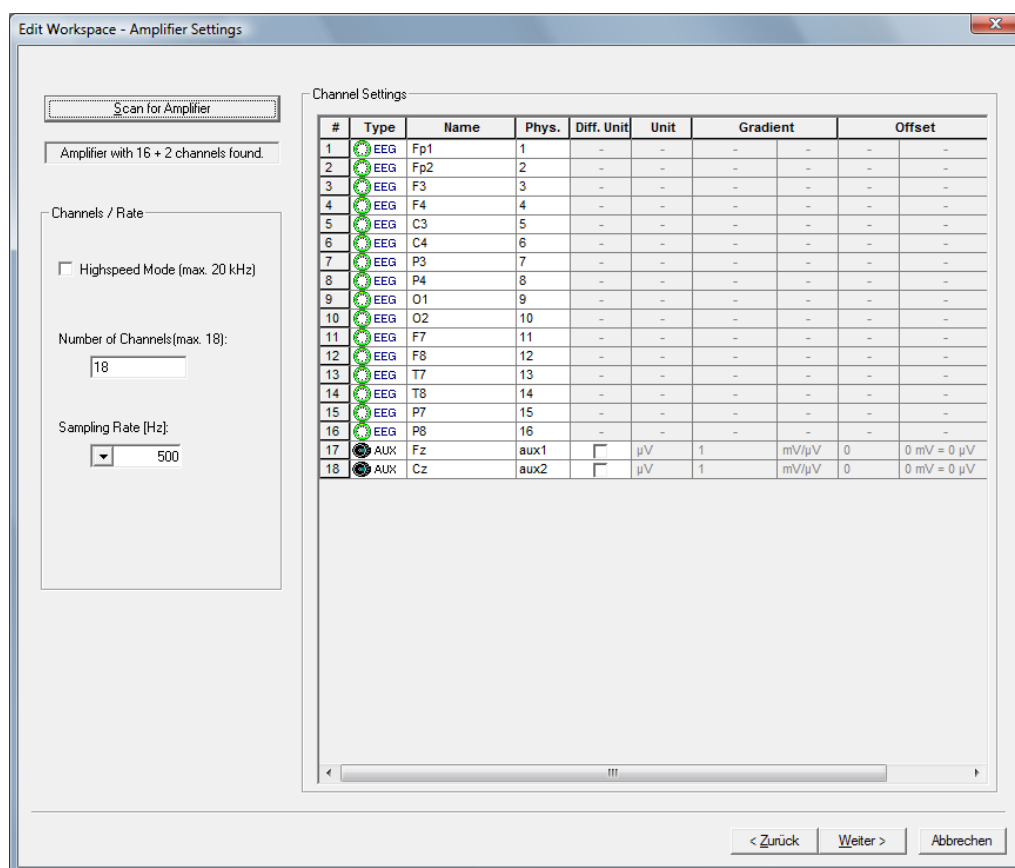


FIGURE 8—20 EDITING A WORKSPACE, PAGE 2 “AMPLIFIER SETTINGS” FOR THE V-AMP AND FIRSTAMP

When you have selected the channels in the **Phys. Chn.** column, additional data entry columns become available in the same way as with the BrainAmp:

- **Diff. Unit:** If you check this box, you can use a different unit, such as “g” for gravitational acceleration.
- **Unit:** Specify the unit here.
- **Gradient:** These columns you to specify the gradient in mV/unit; with a unit “g”, for example, mV/g. In this example, you are describing the voltage difference in mV for a change in gravitational acceleration of 1 g. This value can also be negative.
- **Offset:** The offset defines the zero point. Taking the example of gravitational acceleration, this is the voltage in mV sent by the sensor at 0 g.

### 8.3.2 Configuring the digital port (marker port)

Use the trigger input connectors of the amplifier for recording time-synchronous events such as stimuli or patient responses. Nine digital bit inputs and hence nine bits are available. The first bit is numbered 0 and is located on the Triggers1 port (jack) of the amplifier. All the remaining bits are located on the Triggers2 port. The exact pinout of the socket is given in the Appendix A of the Operating Instructions for the BrainAmp or BrainAmp MR.

You make the settings for the digital port by choosing **Amplifier > Digital Port Settings....**

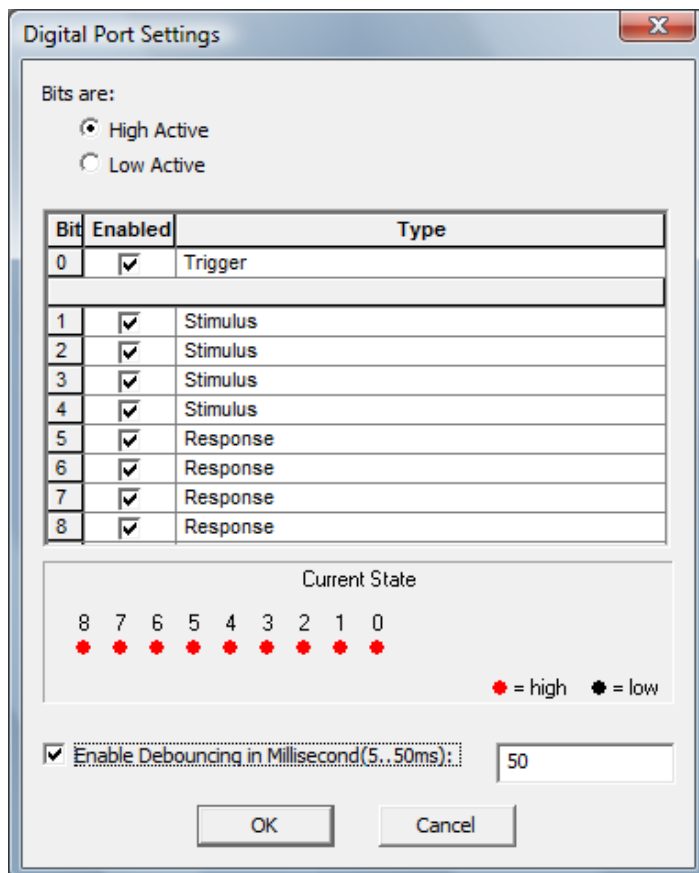


FIGURE 8—21 SETTING THE DIGITAL PORT FOR THE V-AMP AND FIRSTAMP

You can choose whether the signals are interpreted as high-active (5 V = active) or low active (0 V = active).

In the **Enabled** column of the table, you can specify whether the associated bit is to be evaluated or not. In the **Type** column, you can specify what time marker type each bit represents. It is also possible to assign the same type to several different bits.

In principle, you can freely select the name of the type. You should, however, note that BrainVision Recorder and BrainVision Analyzer use color coding for certain types. For this reason, it is advisable to choose “Stimulus” and “Response” for stimulus and response inputs respectively.



The description of the markers is encoded automatically. The following procedure is used: The first occurrence of the type in the table is weighted with value 1, the second occurrence with value 2, the third with value 4 etc. For every data point, all set bits of a type are added together according to this pattern. The resultant number is combined with the initial letter of the type, resulting in the description.

**EXAMPLE**

Bit 4 through bit 7 are of the type “Response2. If bits 5 and 7 are set, this results in a marker of the type “Response” with the description “R 10”. Bit 5 has a value of 2 and bit 7 a value of 8. The total is 10.

The consequence of this logic is that only markers of different types can be detected at any one time. If you want to record different responses simultaneously, you can do so by decoding the number values subsequently in the analysis, i.e. assigning a separate marker to every bit. Alternately, you can assign a separate type to every bit in the table.

You can view the current state of the digital port for test purposes in the **Current State** field.

Another option available in the **Digital Port Settings** dialog box is debouncing. If you check the **Enable Debouncing in Millisecond (5..50 ms)** box, repetition of a marker of the same type and same description is ignored for a period of 5 through 50 ms.



Note that a suitable ratio between the length of the trigger signal and the sampling frequency is required to ensure that the TTL trigger signals are recorded without errors (you make the appropriate settings when you set up the workspace).

The following table contains the recommended minimum length of the trigger signal for various sampling rates. Shorter signal lengths can result in errored markers.

| Sampling rate: | Minimum length of trigger signal: |
|----------------|-----------------------------------|
| 100 Hz         | 25.0 ms                           |
| 250 Hz         | 10.0 ms                           |
| 500 Hz         | 5.0 ms                            |
| 1,000 Hz       | 2.5 ms                            |
| 2,000 Hz       | 2.5 ms                            |
| 5,000 Hz       | 0.5 ms                            |
| 10,000 Hz      | 0.5 ms                            |
| 20,000 Hz      | 0.5 ms                            |

## 8.4 Simulated Amplifier

The Simulated Amplifier function allows you to use the BrainVision Recorder without having an EEG amplifier connected and to display an EEG that has already been recorded. It simulates the activity of up to 256 channels.

The menu bar does not contain the **Amplifier** item if you use the Simulated Amplifier function.



Choose **Configuration > Select Amplifier** from the menu to select the Simulated Amplifier. The **File** menu allows you to make amplifier-specific settings in the same way as with real EEG amplifiers.

Choose **File > Edit Workspace...** from the menu to open the **Edit Workspace – Amplifier Settings** dialog box.

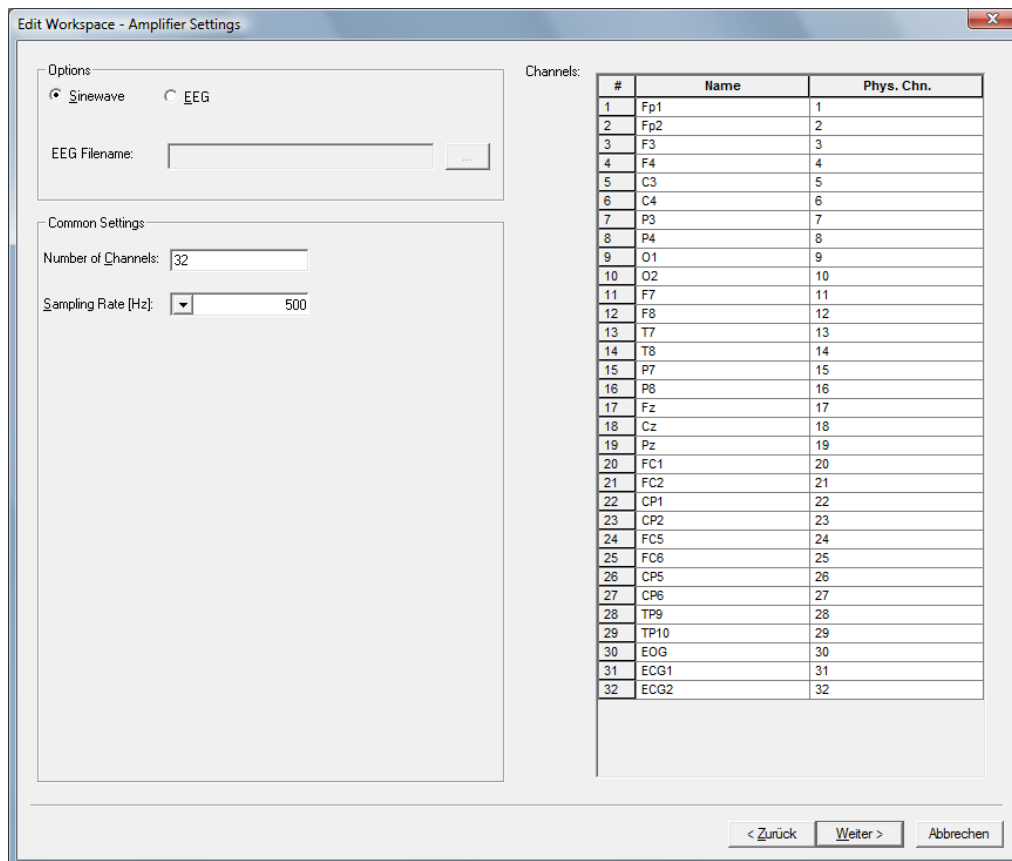


FIGURE 8—22 EDITING A WORKSPACE, PAGE 2 “AMPLIFIER SETTINGS” FOR THE SIMULATED AMPLIFIER

The **Sinewave** and **EEG** options are available:

- If you choose **Sinewave** and enter suitable values under **Common Settings** and **Channels** and in the subsequent menus on the pages **Edit Workspace – Software Filters** and **Edit Workspace – Segmentation/Averaging**, sine waves are displayed during monitoring.

The sine waves vary from channel to channel. Operation is the same as if an amplifier were physically present.

- If you choose **EEG** and then click the  button, a dialog box appears allowing you to open a saved EEG data set.

When you close the dialog box and click the **Monitor**  button, the EEG data set is displayed.

The EEG data is displayed in the same way as with a real amplifier. The EEG data set is repeated in a loop.

When you select the Simulated Amplifier, a separate workspace (the “simulated” workspace) is created and the parameters are taken from the most recent workspace based on a real amplifier.

If you then edit this “simulated” workspace, you can make changes without overwriting the original workspace (based on BrainAmp, QuickAmp USB, QuickAmp PCI, V-Amp/FirstAmp, converter board).

If you then select a real amplifier again, the most recent (non-simulated) workspace is then automatically reloaded without changes.

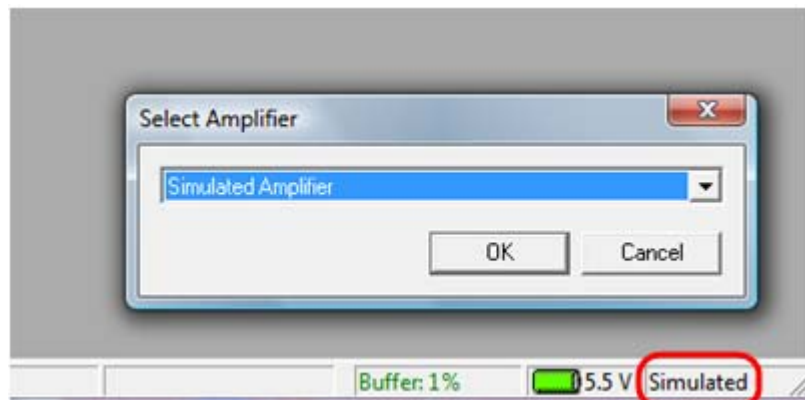


FIGURE 8—23 SIMULATED AMPLIFIER INDICATOR IN THE STATUS BAR

The properties of the simulated workspace (right-click on the file > **Properties**) must not be changed **under any circumstances**.

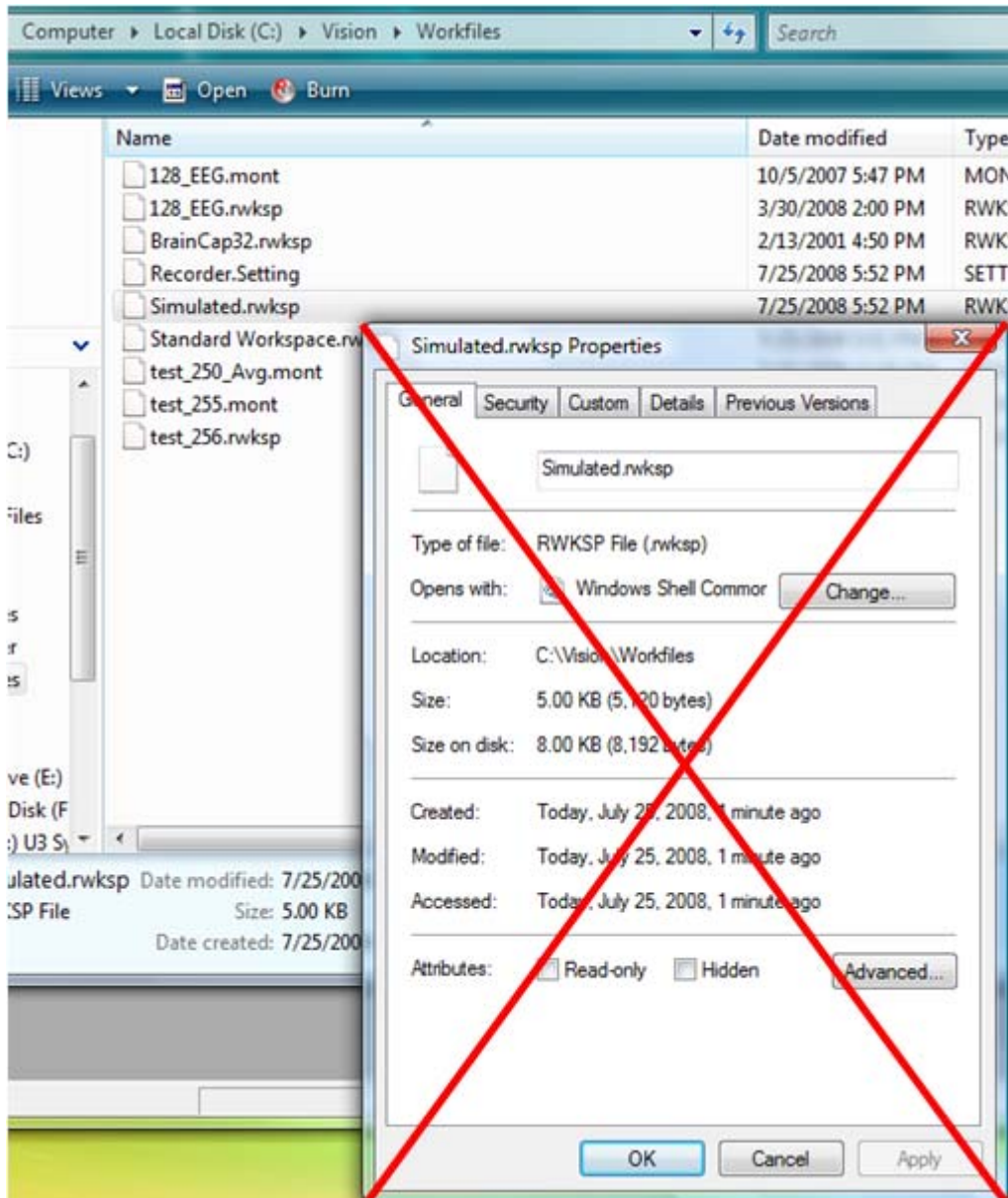


FIGURE 8—24 DO NOT UNDER ANY CIRCUMSTANCES CHANGE THE PROPERTIES OF THE SIMULATED WORKSPACE



## 8.5 National Instruments NI 6071e A/D converter board

Note that the A/D converter board is **NOT** supported under Windows® Vista.

RESTRICTIONS TO USE

You can also enable EEG analog amplifiers to be connected to the BrainVision Recorder using the A/D converter board from National Instruments. The board converts the analog signals of the amplifier into digital signals. The Recorder treats the card just like an amplifier.

Ensure that the EEG amplifier used guarantees the prescribed electrical patient isolation at the analog outputs. Note that the A/D converter board does not provide any electrical isolation between the inputs and the PC.



If analog amplifiers are used, there is no facility for measuring impedance or for injecting an internal test signal.

Please refer to the documents “PCI E Series User Manual.pdf” and “SCB-100 100-Pin Connector Block Installation Guide.pdf” in the subfolder “NI6071e” of the BrainVision installation CD for further information about the A/D converter board.



If you are using the A/D converter board, the **Amplifier** menu contains the items **Digital Port Settings...** and **Driver Version....**

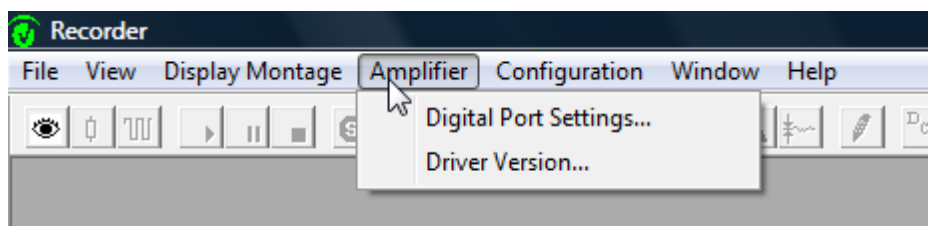


FIGURE 8—25 AMPLIFIER MENU FOR THE A/D CONVERTER BOARD

### 8.5.1 Installation

Do **NOT** use the CD supplied by National Instruments to install the A/D converter board. The drivers on this CD are not compatible with the BrainVision Recorder. Instead, use the BrainVision CD, which contains the correct drivers.



Carry out installation as follows:

- Install the BrainVision Recorder software.
- Shut your PC down and install the A/D converter board in a free PCI slot of the PC.
- Reboot the PC. The New Hardware wizard will prompt you for driver for the new hardware. Insert the BrainVision CD in the CD ROM drive and follow the instructions in the setup program.

8.5.2 Configuration

Choose **Configuration > Select Amplifier > NI 6071e**.

To set the parameters for the A/D converter board, choose **File > Edit Workspace...** and open the page **Edit Workspace – Amplifier Settings**.



Note that the names of the parameters used reflect the terminology used by National Instruments and their meanings may differ from the terms used in neurophysiological research.

| #  | Name | Phys. Chn. | Gain | A/D Range[V] | Resolution[µV] |
|----|------|------------|------|--------------|----------------|
| 1  | Fp1  | 0          | 1000 | ± 5 V        | 2.441406       |
| 2  | Fp2  | 1          | 1000 | ± 5 V        | 2.441406       |
| 3  | F3   | 2          | 1000 | ± 5 V        | 2.441406       |
| 4  | F4   | 3          | 1000 | ± 5 V        | 2.441406       |
| 5  | C3   | 4          | 1000 | ± 5 V        | 2.441406       |
| 6  | C4   | 5          | 1000 | ± 5 V        | 2.441406       |
| 7  | P3   | 6          | 1000 | ± 5 V        | 2.441406       |
| 8  | P4   | 7          | 1000 | ± 5 V        | 2.441406       |
| 9  | O1   | 8          | 1000 | ± 5 V        | 2.441406       |
| 10 | O2   | 9          | 1000 | ± 5 V        | 2.441406       |
| 11 | F7   | 10         | 1000 | ± 5 V        | 2.441406       |
| 12 | F8   | 11         | 1000 | ± 5 V        | 2.441406       |
| 13 | T7   | 12         | 1000 | ± 5 V        | 2.441406       |
| 14 | T8   | 13         | 1000 | ± 5 V        | 2.441406       |
| 15 | P7   | 14         | 1000 | ± 5 V        | 2.441406       |
| 16 | P8   | 15         | 1000 | ± 5 V        | 2.441406       |
| 17 | Fz   | 16         | 1000 | ± 5 V        | 2.441406       |
| 18 | Cz   | 17         | 1000 | ± 5 V        | 2.441406       |
| 19 | Pz   | 18         | 1000 | ± 5 V        | 2.441406       |
| 20 | FC1  | 19         | 1000 | ± 5 V        | 2.441406       |
| 21 | FC2  | 20         | 1000 | ± 5 V        | 2.441406       |
| 22 | CP1  | 21         | 1000 | ± 5 V        | 2.441406       |
| 23 | CP2  | 22         | 1000 | ± 5 V        | 2.441406       |
| 24 | FC5  | 23         | 1000 | ± 5 V        | 2.441406       |
| 25 | FC6  | 24         | 1000 | ± 5 V        | 2.441406       |
| 26 | CP5  | 25         | 1000 | ± 5 V        | 2.441406       |
| 27 | CP6  | 26         | 1000 | ± 5 V        | 2.441406       |
| 28 | TP9  | 27         | 1000 | ± 5 V        | 2.441406       |
| 29 | TP10 | 28         | 1000 | ± 5 V        | 2.441406       |
| 30 | EOG  | 29         | 1000 | ± 5 V        | 2.441406       |
| 31 | FCG1 | 30         | 1000 | ± 5 V        | 2.441406       |

FIGURE 8—26 EDITING A WORKSPACE, PAGE 2 “AMPLIFIER SETTINGS” FOR THE NATIONAL INSTRUMENTS A/D CONVERTER BOARD

“DEVICE SETTINGS”  
GROUP BOX

In the **Device Settings** group box, you can set the **Input Mode**. This must match your chosen wiring configuration. You have three options here:

- **Differential:** Every channel has its own reference. A total of 32 channels are available.
- **Nonref. Single-ended:** Unipolar without a connection to ground. The reference point for all channels is the “AISENSE” terminal.
- **Ref. Single-ended:** Unipolar with a connection to ground. The reference point for all channels is the “AIGND” terminal.

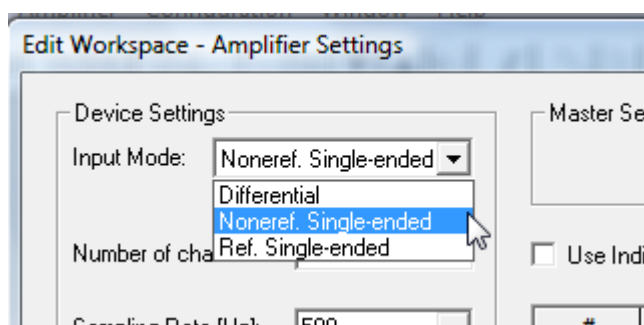


FIGURE 8—27 SELECTING THE INPUT MODE

Please refer to chapter 4, pages 4-13 ff. of the document “PCI E Series User Manual.pdf” on the BrainVision CD for information about optimum wiring of the amplifier used.



You can also specify the **Number of Channels**, the **Sampling Rate** and the **Input Polarity**.

The maximum sampling rate depends on the number of channels. With up to 16 channels you can sample at 2048 Hz, with 32 channels at 1024 Hz and with 64 channels at up to 512 Hz.

The input polarity indicates whether the EEG amplifier supplies a symmetrical or asymmetrical output signal.

The **A/D Range** drop-down list allows you to specify the recording level range of your amplifier.

“MASTER SETTINGS”  
GROUP BOX

Enter the amplification factor of your EEG amplifier in the **Gain** field.

If you do not know the gain, you can determine it empirically. To do this you require a calibration signal which is fed into the amplifier. Choose a realistic gain, e.g. 1000, and then record a short data sequence. Measure the values in the analysis software. You can now correct the gain by comparing the actual value with what it should be.

Set the gain to 1000 and feed in a test voltage of  $100\mu\text{V}_{\text{pp}}$ . The voltage measured in the analysis software is  $120\mu\text{V}_{\text{pp}}$  for example.

EXAMPLE

Correct the gain:  $\text{new value} = \text{old value} * 120\mu\text{V} / 100\mu\text{V} = 1200$ .

Now enter the new value and repeat the test. The value of the signal feed and the measured value should now match.

If you require individual settings for each channel, check the **Use Individual Settings** box.

### 8.5.3 Configuring the digital port (marker port)

Use the digital ports DIO0 through DIO7 for recording time-synchronous events such as stimuli or patient responses. The designations DIO0 through DIO7 relate to the bit number, with the first bit being designated with 0.

You make the settings for the digital port by choosing **Amplifier > Digital Port Settings....**

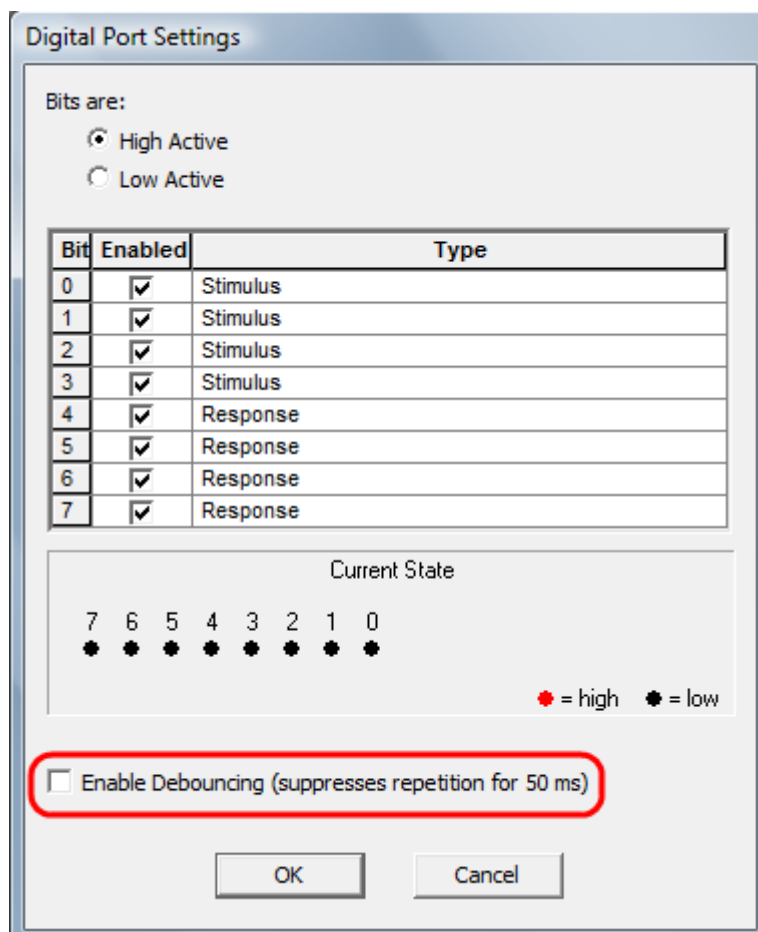


FIGURE 8—28 DIGITAL PORT SETTINGS FOR THE NATIONAL INSTRUMENTS A/D CONVERTER BOARD

You can choose whether the signals are interpreted as high-active (5 V = active) or low active (0 V = active).

In the **Enabled** column of the table, you can specify whether the associated bit is to be evaluated or not. In the **Type** column, you can specify what time marker type each bit represents. It is also possible to assign the same type to several different bits.



In principle, you can freely select the name of the type. You should, however, note that BrainVision Recorder and BrainVision Analyzer use color coding for certain types. For this reason, it is advisable to choose “Stimulus” and “Response” for stimulus and response inputs respectively.

The description of the markers is encoded automatically. The following procedure is used: The first occurrence of the type in the table is weighted with value 1, the second occurrence with value 2, the third with value 4 etc. For every data point, all set bits of a type are added together according to this pattern. The resultant number is combined with the initial letter of the type, resulting in the description.

Bit 4 through bit 7 are of the type “Response”. If bits 5 and 7 are set, this results in a marker of the type “Response” with the description “R 10”. Bit 5 has a value of 2 and bit 7 a value of 8. The total is 10.

EXAMPLE

The consequence of this logic is that only markers of different types can be detected at any one time. If you want to record different responses simultaneously, you can do so by decoding the number values subsequently in the analysis, i.e. assigning a separate marker to every bit. Alternately, you can assign a separate type to every bit in the table.

You can view the current state of the digital port for test purposes in the **Current State** field.

Another option available in the **Digital Port Settings** dialog box is debouncing. If you check the **Enable Debouncing (suppresses repetition for 50 ms)** box, repetition of a marker of the same type and same description is ignored for a period of 50 ms.

Note that trigger signals must be present at least for the extent of a sampling point. This means, for instance, that at a sampling rate of 1000 Hz, the minimum length of the trigger signal is 1 ms. At 500 Hz, the minimum length is 2 ms etc.





## 9 OLE Automation

The BrainVision Recorder can be controlled remotely by other programs using OLE automation methods.

The program ID (ProgID) for external access to the Recorder is “VisionRecorder.Application”. The Recorder incorporates a registered type library which is stored in “Recorder.exe”. The entry for the type library in the Registry is “Vision Recorder x.x Type Library” where x.x stands for the current version.

Under Windows® XP and Vista, the Recorder can also be controlled, for example, via a VB script batch file, as shown below:

```
' TestRecorder
' Create recorder object
Set Rec = CreateObject("VisionRecorder.Application")
Rec.Acquisition.ViewData()
Rec.Acquisition.StartRecording(Rec.CurrentWorkspace.RawFileFolder & "\TestData.eeg")
WScript.Sleep 5000 ' Analyzer Macro: use Wait 5
Rec.Acquisition.StopRecording()
Rec.Acquisition.StopViewing()
Rec.Quit
```

In this example, the Recorder is started, data is displayed and an EEG file named “TestData.EEG” with a length of 5 seconds (5,000 milliseconds) is stored.

If you are using the BrainVision Analyzer EEG analysis software, you can also control the Recorder by means of an Analyzer macro. The macro looks like this:

```
' TestRecorder
Sub Main
    ' Create recorder object
    Set Rec = CreateObject("VisionRecorder.Application")
    Rec.Acquisition.ViewData()
    Rec.Acquisition.StartRecording(Rec.CurrentWorkspace.RawFileFolder & "\TestData.eeg")
    Wait 5
    Rec.Acquisition.StopRecording()
    Rec.Acquisition.StopViewing()
    Rec.Quit
End Sub
```

In this chapter, we will not deal with programming in depth but will just outline the Recorder's object model.

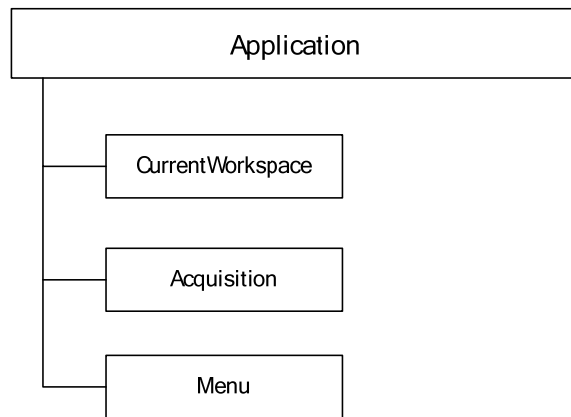


FIGURE 9—1 RECORDER OBJECT HIERARCHY

The objects are described in Visual Basic notation in the following sections.

## 9.1 Application

### Description

The Application object represents the program as a whole. It is the default object, which means that the methods and properties of this object can be addressed directly, i.e. “Version” corresponds to “Application.Version”, for example.

### Methods

Sub Quit()  
Terminates the program.

### Properties

Acquisition As Acquisition  
Write-protected  
The Acquisition object.

CurrentWorkspace As CurrentWorkspace  
Write-protected  
The current workspace.

Menu As Menu  
Write-protected  
The Menu object.

State As VisionRecorderState  
Write-protected  
The program status, see below for enumerator types.

SubLicenses As Licenses  
Write-protected  
Lists the registered sub-licenses.

Version as double  
Write-protected  
Specifies the current program version.

## 9.2 Acquisition

### Description

This object controls recording.

### Methods

`Sub Continue()`  
This resumes interrupted recording.

`Sub DCCorrection()`  
This performs a DC correction.

`Sub Pause()`  
This interrupts recording

`Sub StartRecording(FileName As String, [sComment As String])`  
This starts recording to "FileName".  
An optional comment can be specified.

`Sub StopRecording()`  
This stops recording.

`Sub StopViewing()`  
This stops the viewing of data, test signals or impedance measurements.

`Sub ViewData()`  
This displays data, or starts monitoring.

`Sub ViewTestSignal()`  
This displays test signals.

`Sub ViewImpedance()`  
This displays impedance measurements.

## 9.3 Current Workspace

### Description

This object represents the current workspace.

### Methods

Sub Load(FileName As String)  
    This loads the specified workspace file "FileName".

### Properties

FullName As String  
    Write-protected  
    Name of the workspace file including full path.

Name As String  
    Write-protected  
    Base name of the workspace file without folder and file name extension.

RawFileFolder  
    Write-protected  
    Folder for raw data.

## 9.4 License

### Description

This object describes a license/sub-license (e.g. a video sub-license).

### Methods

./.

### Properties

ID As Long  
    Write-protected  
    Unique ID of the license.

Description As String  
    Write-protected  
    Description of the license.

## 9.5 Licenses

### Description

This object comprises a list of "License" objects.

### Methods

./.

### Properties

Count As Long

Write-protected

Number of licenses in the list.

Item(Index As Long) As License

Default element, write-protected

On specifying the index (1-...), returns a "License" object.

## 9.6 Menu

### Description

This object allows manipulation of the menu.

### Methods

Sub DisableMenuItem(MenuItem As VisionRecorderMenuItem)

This disables a menu option; the option to be disabled is specified in "MenuItem"  
(see below for enumerator types).

Sub EnableMenuItem(MenuItem As VisionRecorderMenuItem)

This enables a menu option; the option to be enabled is specified in "MenuItem"  
(see below for enumerator types).

Sub Reset()

This resets all manipulated menu options.

## 9.7 Enumerator types

The following sections describe the various enumerator types.

### 9.7.1 VisionRecorderMenuItem

Constants for the various menu items that can be addressed with the Menu object:

```
Enum VisionRecorderMenuItem
    vrMiMonitoring = 32777,
    vrMiImpedanceCheck = 32778,
    vrMiTestsignal = 32779,
    vrMiStartRecording = 32791,
    vrMiPauseRecording = 32792,
    vrMiStopRecording = 32793,
    vrMiStop = 32780,
End Enum
```

### 9.7.2 VisionRecorderState

Constants for the various states of the program:

```
Enum VisionRecorderState
    vrStateOff = 0           ' Idle state
    vrStateMonitoring = 1    ' Viewing EEGs
    vrStateTestsignal = 2    ' Test signal
    vrStateImpedanceCheck = 3 ' Impedance measurement
    vrStateSaving = 4        ' Saving data
    vrStateSavingTestsignal = 5 ' Saving test signals
    vrStatePause = 6         ' Data saving paused
    vrStatePauseTestsignal = 7 ' Data saving paused,
                                ' displaying test signal
    vrStatePauseImpedanceCheck = 8 ' Data saving paused,
                                ' displaying impedance
                                ' measurement
End Enum
```



## 10 Remote data access

While it is being displayed, the EEG data can be passed to other programs on the local PC and to PCs in a network via TCP/IP. This is referred to as remote data access (RDA). In this process, the Recorder acts as the server, and the program receiving the data acts as a client.

Up to ten clients can be logged in to the RDA server at the same time.

This chapter describes the interface that enables you to implement your own online analysis programs or bio-feedback methods. In principle, you can use different programming languages to do this. You can also develop and run a client program under Linux or other operating systems.

RDAClient is a program that was developed with Microsoft Visual C++ Version 6.0 under Windows®. You can find the example project on the BrainVision program CD in the "RDAClient" folder. RDAClient establishes the connection to the server, and then waits for data in a loop. When data arrives, it is stored in BrainVision-compatible EEG files. The name of the computer on which the Recorder is running is passed to the program as an argument. If this argument is not specified, the local computer is examined.

EXAMPLE

There are two versions of the RDAClient: a 16-bit version and a 32-bit version. The 16-bit version works with amplifiers and A/D converters with an A/D range of a maximum of 16 bits. The 32-bit version covers an A/D range of up to 25 bits.

Before the RDA server can run it must have been enabled in the Recorder software. To do this, choose **Configuration > Preferences...**, select the **Remote Data Access** tab and check the **Enable Remote Data Access** box.

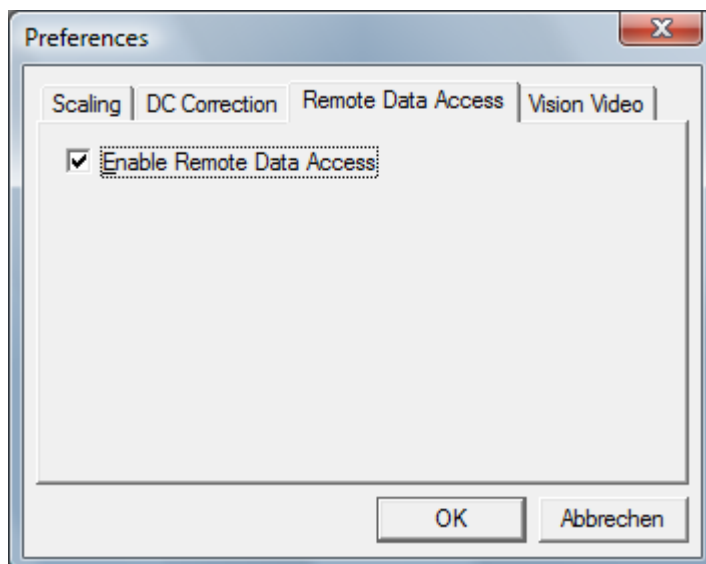


FIGURE 10—1 ACTIVATING THE RDA SERVER

One key term in programming involving TCP/IP is “socket”. A socket is the combination of a TCP/IP address and a port number. This combination describes a specific service on a computer. One well-known, implicitly used service is, for example, the HTTP protocol on a Web server. This uses port number 80 by default. The Recorder's RDA server uses two port numbers: 51234 and 51244. The first port is used for 16-bit data, the second port for 32-bit data.



The first task of the client program is to establish a connection to the server's RDA service using the port number. This is done using standard socket programming that we will not explain here. However, you can find an example of it in `RDAClient.cpp` or `RdaClient32.cpp`.

Then the client waits for data or messages to be sent from the server. The client itself never sends data to the server.

Every data block received contains a header of the type `RDA_MessageHeader`. You can find the declaration of this header and all other structures and constants in the file `RecorderRDA.h`. The header consists of three parts:

- *guid* is a 128-bit constant for unique identification.
- *nSize* describes the total length of the block.
- *nType* describes the type of this message. Four message types are in use at present: 1 means the start of message (*RDA\_MessageStart*), 2 means data block (*RDA\_MessageData*) for clients of the 51234 socket, 3 means end of message (*RDA\_MessageStop*) and 4 means data block (*RDA\_MessageData32*) for clients of the 51244 socket.

These different messages are described below.

#### **RDA\_MessageStart (nType = 1)**

This message is sent by the server

- when it switches to monitoring mode
- after a client has logged in during monitoring.

In addition to the header, data is sent on the number of channels (*nChannels*), the sampling interval in  $\mu\text{S}$  (*dSamplingInterval*), the sensitivity of the channels in  $\mu\text{V}$  separately for each channel (*dResolutions*) and the channel names (*sChannelNames*). The size of the *dResolutions* field is flexible and depends on the value of *nChannels*. *sChannelNames* contains all channel names in one string. The individual channel names are null-terminated.

The `WriteHeaderFile(RDA_MessageStart* pMsg)` routine in `RDAClient.cpp` shows how the fields can be exploded.

**RDA\_MessageData (nType = 2)**

This message is only received by clients that have logged in via port number 51234.

This message is used to transfer 16-bit data. It consists of the following elements:

- *nBlock* specifies the current block number since the start of monitoring. The number can be used to identify whether a block has not been processed fast enough, thus causing a data overflow. An example of this is given in `RDAClient.cpp`.
- *nPoints* specifies the number of data or sampling points in this block.
- *nMarkers* defines the number of markers in this data block.
- *nData[]* is the actual data in the form of 16-bit signed integers. The number of values is derived from *nPoints* and *RDA\_MessageStart.nChannels*.
- *Markers* is a data field with markers of the *RDA\_Marker* type. The individual elements of this field can have different lengths.

A marker of the *RDA\_Marker* type consists of the following:

- *nSize*: the size of the marker in bytes,
- *nPosition*: the relative position in the data block in sampling points (0 -...),
- *nPoints*: the number of points covered by this marker (mostly 1),
- *nChannel*: the channel number to which this marker has been assigned (at present only -1 = all markers),
- *sTypeDesc*: type and description of the marker as null-terminated text.

You will find examples of how to handle data and markers in `RDAClient.cpp` in the routines `WriteDataBlock(RDA_MessageData* pMsg)` and `WriteMarkers(RDA_MessageData* pMsg, ULONG nOffset, ULONG nExistingMarkers)`.

**RDA\_MessageStop (nType = 3)**

This message consists of the header only, and indicates the end of monitoring.

**RDA\_MessageData32 (nType = 4)**

This message is only received by clients that have logged in via port number 51244.

Its structure is identical to that of *RDA\_MessageData* with the exception of the *fData[]* field, which replaces the *nData[]* field.

*fData[]* is the current data in the 32-bit IEEE floating point format. The number of values is derived from *nPoints* and *RDA\_MessageStart.nChannels*.



## 11 BrainVision Video Recorder

The Brain Vision Video Recorder (or simply “Video Recorder” for short) is used for the synchronous recording of video data and EEG data in conjunction with the BrainVision Recorder.

### 11.1 Installation

In order to use the Video Recorder, BrainVision Recorder with version number 1.02.0001 or higher must have been previously installed.

As of version 1.03 of the Recorder, you also install the Brain Products license file you received with the product.

Make sure that you have a USB dongle with video option. Check this by starting the Recorder and choosing **Help > About Recorder:**

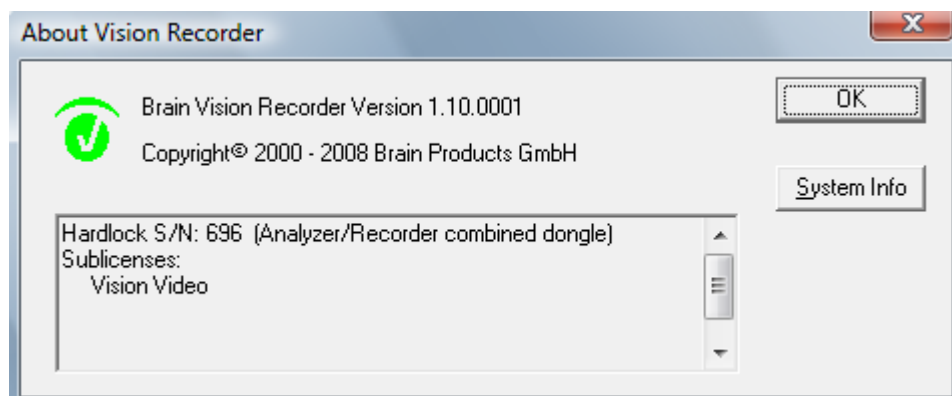


FIGURE 11—1 PROGRAM INFORMATION

If you have the appropriate USB dongle, the line “Vision Video” will appear.

To install the Video Recorder, run the Setup program on the CD supplied and follow the installation instructions.

Now install the codec supplied. A codec is used to compress the video data.

Connect the video camera and switch it on.

Note that some video cameras with a video tape inserted switch over to standby mode after a set time. Since we store the data directly in the computer, no video tape is required



## 11.2 Configuration

To configure the Video Recorder, choose **Configuration > Preferences** in the Recorder.

If you have installed the Video Recorder correctly and you have a dongle with a video license, the **Preferences** dialog box will contain an additional tab named **Vision Video**.

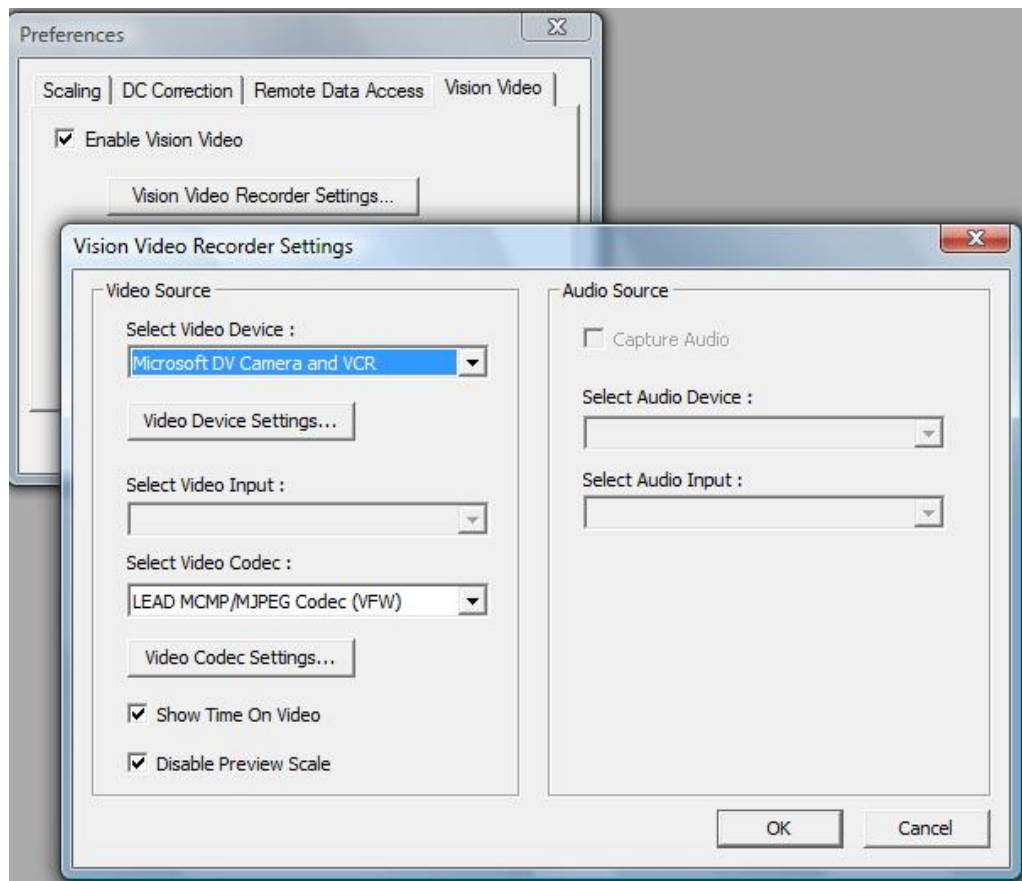


FIGURE 11—2 VIDEO SETTINGS AND SELECTING THE CODEC

Enable synchronous video recording by checking the Enable Vision Video box.

Click the Vision Video Recorder Settings button. You can make the following settings:

- Choose the installed video camera under **Select Video Device**.
- **Video Device Settings** allows you to access the settings for the camera.
- If you have connected analog video devices, **Select Video Input** allows you to select between different input options (such as Video Tuner, SVideo, Composite).



However, we recommend that you use digital video equipment.

- You can select a codec by clicking **Select Video Codec**.

Note that most codecs offered are not suitable for real-time recording, so choose either the codec supplied or one that you know is capable of meeting the requirements.



Click the **Video Codec Settings...** button to set the optimum balance between image quality and video file size. Experiment with different settings by recording part of an EEG in conjunction with the Video Recorder and looking at the resulting quality and file size.

For debugging purposes, choose the codec **None**. In this case the video data is not compressed. You should, however, select this option for test purposes only.



- **Show Time on Video** shows the date and time on the video.
- If you check the **Disable Preview Scale** box, you cannot change the size of the video window.
- Check the **Capture Audio** box if you also wish to record audio information.
- **Select Audio Device** is used to select the audio recording device.
- If you have connected analog audio devices, **Select Audio Input** allows you to select between different input options (such as line-in, microphone, phone).

However, we recommend that you use digital audio equipment.



### 11.3 Combined EEG/video recording

Once you have selected a suitable codec, choose monitoring mode in the Recorder by clicking the **Monitor**  button.

This brings up a window with EEG data as well as a video window in which the current video data is displayed.

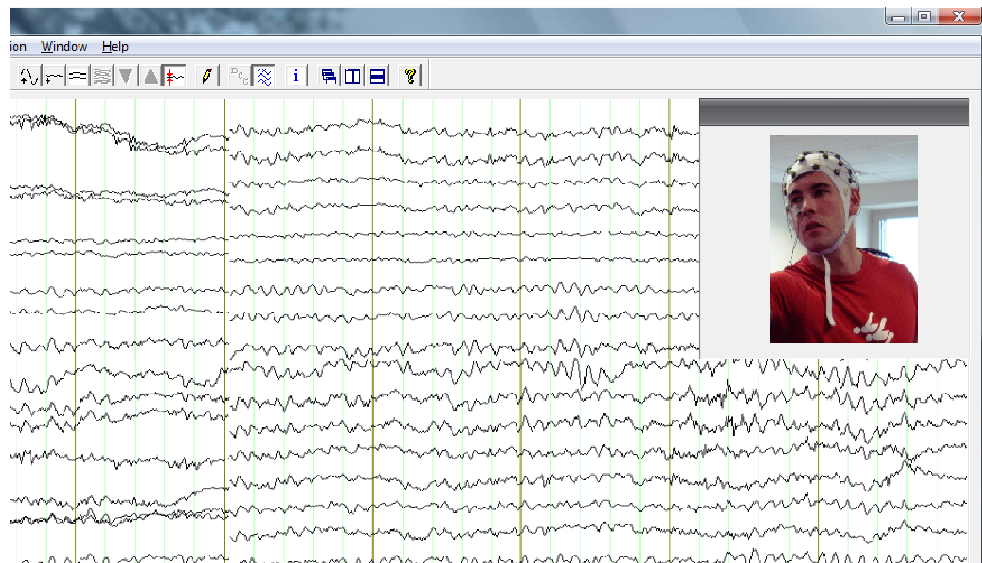


FIGURE 11—3 COMBINED EEG/VIDEO DISPLAY (EXTRACT)



If the video camera is not ready, the video window will show the message “Camera Not Connected!”. If the display is black, the most likely cause is that an incompatible codec has been selected. In this case, select a different codec.

You can move and resize the video window using the mouse.

Now record part of an EEG, for example 10 seconds. Make sure that the video image does not disappear. If you pan with the camera, this should also be visible after a short delay of less than a second. If not, the codec used is not suitable.

A constant delay of the displayed video data of less than a second is, however, normal. This does not result in any time difference between the video and the EEG when subsequently replayed in the BrainVision Analyzer.

The video data is saved in the current raw data folder. A file with the extension “.VIDEOCONFIG” and the base name of the EEG file contains detailed information about the video (names of video files, time, length etc.). The actual video data is saved to a file with the extension “.VISIONVIDEO”. A new video file is created after every pause in recording. It is therefore possible for one EEG file to be associated with several video files.

You should always check the size of the video files generated. A value of 150 to 300 kbytes per second is possible while maintaining good quality. If, however, your video files have a size of several megabytes per second, either an unsuitable codec or no codec is selected.

## Appendix – EEG file format

The current version of the BrainVision Recorder supports the BrainVision Data Exchange Format only. This format is described below.

An EEG consists of three files: the header file, the marker file and the actual data.

The header file describes the EEG. This file is an ASCII file with the extension “.vhdr”. It will normally be given the same base name as the raw data EEG that is described in it. The header file is stored in the raw data folder of the workspace.

The format of the header file is based on the Windows INI format. It consists of sections with different names containing keyword/value pairs. Here is an extract from a header file:

```
Brain Vision Data Exchange Header File Version 1.0
; Data created by the Vision Recorder

[Common Infos]
Codepage=UTF-8
DataFile=000007.eeg
MarkerFile=000007.vmrk
DataFormat=BINARY
; Data orientation: MULTIPLEXED=ch1,pt1, ch2,pt1 ...
DataOrientation=MULTIPLEXED
NumberOfChannels=48
; Sampling interval in microseconds
SamplingInterval=5000

[Binary Infos]
BinaryFormat=INT_16

[Channel Infos]
; Each entry: Ch<Channel number>=<Name>,<Reference channel name>,
; <Resolution in "Unit">,<Unit>, Future extensions..
; Fields are delimited by commas, some fields might be omitted (empty).
; Commas in channel names are coded as "\1".
Ch1=1,,0.1,µV
Ch2=2,,0.1,µV
...
Ch41=41,,0.1526,C
Ch42=42,,0.0763,mm
Ch43=43,,0.1526,mm
Ch44=44,,152.6,µV
...
```

```

[Comment]

A m p l i f i e r   S e t u p
=====
Number of channels: 48
Sampling Rate [Hz]: 200
Sampling Interval [µS]: 5000

Channels
-----
#      Name  Phys.  Resolution/  Low  High  Notch  Gradient  Offset
      Chn    Unit           Cutoff[s] Cutoff[Hz] [Hz]
1      1      1      0.1 µV      DC      250      Off
2      2      2      0.1 µV      DC      250      Off
...
41     41     41      0.1526 C      DC      250      Off  1[mV/C]  0.02[mV] =
                                0[C]
42     42     42      0.0763 mm      DC      251      Off  2[mV/mm]  0[mV] =
                                0[mm]
43     43     43      0.1526 mm      DC      252      Off  1[mV/mm]  1[mV] =
                                0[mm]
44     44     44      152.6 µV      DC      253      Off
...

S o f t w a r e   F i l t e r s
=====
#      Low Cutoff [s]  High Cutoff [Hz]  Notch [Hz]
1      0.0006366      Off              Off
2      0.0006366      Off              Off
...
41     0.0006366      Off              Off
42     0.0006366      Off              Off
43     0.0006366      Off              Off
44     0.0006366      Off              Off
...

Impedance [kOhm] at 12:10:43:
1:      Out of Range!
2:      Out of Range!
...
41:     Out of Range!
42:     Out of Range!
43:     Out of Range!
44:     Out of Range!
...
Ref:    Out of Range!
Gnd:    Out of Range!

```

The first line identifies the header file and is mandatory.

A semicolon at the beginning of a line identifies a free-text comment. This line is ignored. Blank lines are also ignored. A section is introduced by a line with a term enclosed in square brackets. The header extract above, for example, contains the “Common Infos” section. A header file can contain any number of sections.

The subsequent lines contain some keywords for this section and the values that have been assigned to them. A keyword can only occur once in a section. Its meaning depends on the section in which it occurs. There must be no blank before or after the assignment operator. Most predefined keywords have a predefined value which is used by the Generic Data Reader if a keyword is not found.

The amplifier setup parameters are listed in the “Amplifier-Setup” section. The individual parameters are described in section 5.3.2 (Edit Workspace – Amplifier Settings dialog box).

The various predefined sections with keywords, their meanings and default values are listed below.

| <b>Common Infos</b><br>This section contains general information on the EEG file. |                                                                                                                                                                                                                                                                                                                                                                                                 |                                  |
|-----------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------|
| <b>Keyword</b>                                                                    | <b>Meaning</b>                                                                                                                                                                                                                                                                                                                                                                                  | <b>Default</b>                   |
| DataFile                                                                          | Name of the EEG file. If the name does not contain a path, it is assumed that the EEG file is in the same folder as the header file. The placeholder \$b can be used in the name. It is replaced by the base name of the header file when the file is read in. Example: The entry <b>DataFile=\$b-EEG.dat</b> in a header file named Test.vhdr is interpreted as <b>DataFile=Test-EEG.dat</b> . | None, a value must be specified. |
| MarkerFile                                                                        | Optional marker file containing a list of markers assigned to the EEG. If no path is specified explicitly, the program looks for the marker file in the folder in which the header file is located. The format of the marker file is explained further below. The placeholder \$b can be used in the name.                                                                                      | -                                |
| DataFormat                                                                        | Possible values:<br><b>ASCII, BINARY</b>                                                                                                                                                                                                                                                                                                                                                        | ASCII                            |
| DataOrientation                                                                   | Possible values:<br><b>VECTORIZED</b><br>All the data points for the first channel appear first in the file, followed by those of the second channel etc.<br><b>MULTIPLEXED</b><br>The values for all channels follow each other for each data point.                                                                                                                                           | MULTIPLEXED                      |
| DataType                                                                          | Possible values:<br><b>TIMEDOMAIN</b><br>The data is in the time domain.<br><b>FREQUENCYDOMAIN</b><br>The data is in the frequency domain.                                                                                                                                                                                                                                                      | TIMEDOMAIN                       |
| NumberOfChannels                                                                  | Number of channels in the EEG file.                                                                                                                                                                                                                                                                                                                                                             | None, a value must be specified. |

## COMMON INFOS

COMMON INFOS  
(CONTINUED)

| Keyword           | Meaning                                                                                                                                                                                                                                                                                                                                                                                                                                                 | Default                          |
|-------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------|
| SamplingInterval  | The sampling interval is specified in $\mu$ s in the time domain and in hertz in the frequency domain.                                                                                                                                                                                                                                                                                                                                                  | None, a value must be specified. |
| Averaged          | This indicates whether the data set which is to be read in has already been averaged. This is particularly relevant for enabling and disabling transforms in the Transformations menu.<br>Possible values:<br><b>YES</b> - Yes, the data set represents data that has been averaged.<br><b>NO</b> - No, the data set represents data that has not been averaged.                                                                                        | NO                               |
| AveragedSegments  | Number of segments that were included in averaging. This value is only evaluated if Averaged=YES.                                                                                                                                                                                                                                                                                                                                                       | 0                                |
| SegmentDataPoints | If the data is segmented evenly, then the number of data points per segment can be specified here.                                                                                                                                                                                                                                                                                                                                                      | 0                                |
| SegmentationType  | Like Averaged, this variable is relevant for enabling and disabling transforms in the Transformations menu in the Analyzer.<br>Possible values:<br><b>NOTSEGMENTED</b><br>The data set has not been segmented.<br><b>MARKERBASED</b><br>The data set has been segmented on the basis of one or more marker positions. All segments have the same length.<br><b>FIXTIME</b><br>Segmentation was based on fixed times. All segments have the same length. | NOTSEGMENTED                     |
| DataPoints        | Number of data points in the EEG file. If no predefined value is specified, data is read to the end of the file. As far as binary data is concerned, the TrailerSize parameter can be set in the "Binary Infos" section as an alternative.                                                                                                                                                                                                              | 0                                |
| Codepage          | Codepage used in the header file.<br>Possible values:<br><b>UTF-8, ANSI</b>                                                                                                                                                                                                                                                                                                                                                                             | ANSI                             |

| <b>ASCII Infos</b><br>This section is only relevant if DataFormat in the [Common Infos] section was set to "ASCII". |                                                                                                                                         |                |
|---------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------|----------------|
| <b>Keyword</b>                                                                                                      | <b>Meaning</b>                                                                                                                          | <b>Default</b> |
| DecimalSymbol                                                                                                       | Decimal symbol that is used in the EEG file. This symbol can be a dot or comma. In the header file, the decimal symbol is always a dot. | Dot (.)        |
| SkipLines                                                                                                           | Number of header lines to be skipped.                                                                                                   | 0              |
| SkipColumns                                                                                                         | Number of columns to be skipped at the beginning of a line.                                                                             | 0              |

## ASCII INFOS

| <b>Channel Infos</b><br>This section lists the individual channels and their properties.                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                                    |
|--------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------|
| <b>Keyword</b>                                                                                                           | <b>Meaning</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | <b>Default</b>                                                     |
| Ch<x>; "x" stands for the channel number, i.e. the keyword for the first channel is Ch1, for the second channel Ch2 etc. | Individual properties for the channel are specified separated by commas:<br><Channel Name>,<Reference Channel Name>,<br><Resolution in "Units">,<Unit><br>Example:<br>Ch1=Fp1,,1<br>The first channel is named "Fp1". The reference channel is assumed to be the common reference channel because no entry has been made and the resolution is 1 µV. The resolution is the value by which the value of the data point is multiplied to convert it to µV or to the selected unit. | <Channel number>,,1,µV, for channel 1, for example:<br>Ch1=1,,1,µV |

## CHANNEL INFOS

| <b>Binary Infos</b><br>This section is only relevant if DataFormat in the [Common Infos] section was set to "BINARY". |                                                                                                                                                                                                     |                |
|-----------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------|
| <b>Keyword</b>                                                                                                        | <b>Meaning</b>                                                                                                                                                                                      | <b>Default</b> |
| BinaryFormat                                                                                                          | Possible values:<br><b>IEEE_FLOAT_32</b><br>IEEE floating point format, single precision, 4 bytes per value.<br><b>INT_16</b><br>16-bit signed integer<br><b>UINT_16</b><br>16-bit unsigned integer | INT_16         |
| ChannelOffset                                                                                                         | Channel offset at which the data starts. This offset is only relevant with vectorized data. "ChannelOffset" and "DataOffset" can be used simultaneously.                                            | 0              |
| DataOffset                                                                                                            | Size of the offset in the file at which the actual data starts.                                                                                                                                     | 0              |

## BINARY INFOS

BINARY INFOS  
(CONTINUED)

| Keyword           | Meaning                                                                                                                                                                                                                                                                                                                                     | Default |
|-------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------|
| SegmentHeaderSize | If the data is segmented evenly, the size in bytes of the segment header can be entered here.                                                                                                                                                                                                                                               | 0       |
| TrailerSize       | Size in bytes of the trailer of the EEG file. This parameter can be specified as an alternative to "DataPoints" in [Common Infos] in order to stop reading in the data before the end of the EEG file is reached.                                                                                                                           | 0       |
| UseBigEndianOrder | This only applies to integer formats. It specifies whether big endian order is used, i.e. whether the most significant byte in a number is stored first (Macintosh, Sun).<br>Possible values:<br><b>YES</b><br>Yes, big endian order is in use.<br><b>NO</b><br>No, little-endian order is in use (corresponds to the Intel specification). | NO      |

The marker file is based on the same principle of sections and keywords as the header file.

The first line identifies the marker file and is as follows:

```
Brain Vision Data Exchange Marker File Version 1.0
```

The various predefined sections with keywords, their meanings and default values are listed below.

## COMMON INFOS

| Common Infos                                                  |                                                                                                                                                                                                    |         |
|---------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------|
| This section contains general information on the marker file. |                                                                                                                                                                                                    |         |
| Keyword                                                       | Meaning                                                                                                                                                                                            | Default |
| DataFile                                                      | Name of the EEG file. If the name does not contain a path, it is assumed that the EEG file is in the same folder as the marker file. This information is not evaluated by the Generic Data Reader. | -       |

| <b>Marker Infos</b><br>This section lists the individual markers and their properties.                                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                |
|-----------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------|
| <b>Keyword</b>                                                                                                        | <b>Meaning</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | <b>Default</b> |
| Mk<x>; "x" stands for the marker number, i.e. the keyword for the first marker is Mk1, for the second marker Mk2 etc. | <p>Individual properties for the marker are specified separated by commas:<br/>           &lt;Type&gt;,&lt;Description&gt;,&lt;Position&gt;,&lt;Points&gt;,&lt;Channel Number&gt;,&lt;Date&gt;</p> <p>Example:<br/>           Mk1=Time 0,,26,1,0</p> <p>The first marker has the type "Time 0", no description, the position is at data point 26, the length is 1 data point, and the channel number is 0 which means that this marker relates to all channels.</p> <p>The date is optional. It is only evaluated if the marker type is "New Segment". The date has the following format:<br/>           4 digits = year<br/>           2 digits = month<br/>           2 digits = day<br/>           2 digits = hour (24-hour system)<br/>           2 digits = minute<br/>           2 digits = second<br/>           6 digits = microsecond</p> <p>This means that the time resolution is one microsecond.</p> <p>The date specification<br/>           19990311140312000000<br/>           means March 11, 1999, 14:03:12.003012</p> | -              |

## MARKER INFOS